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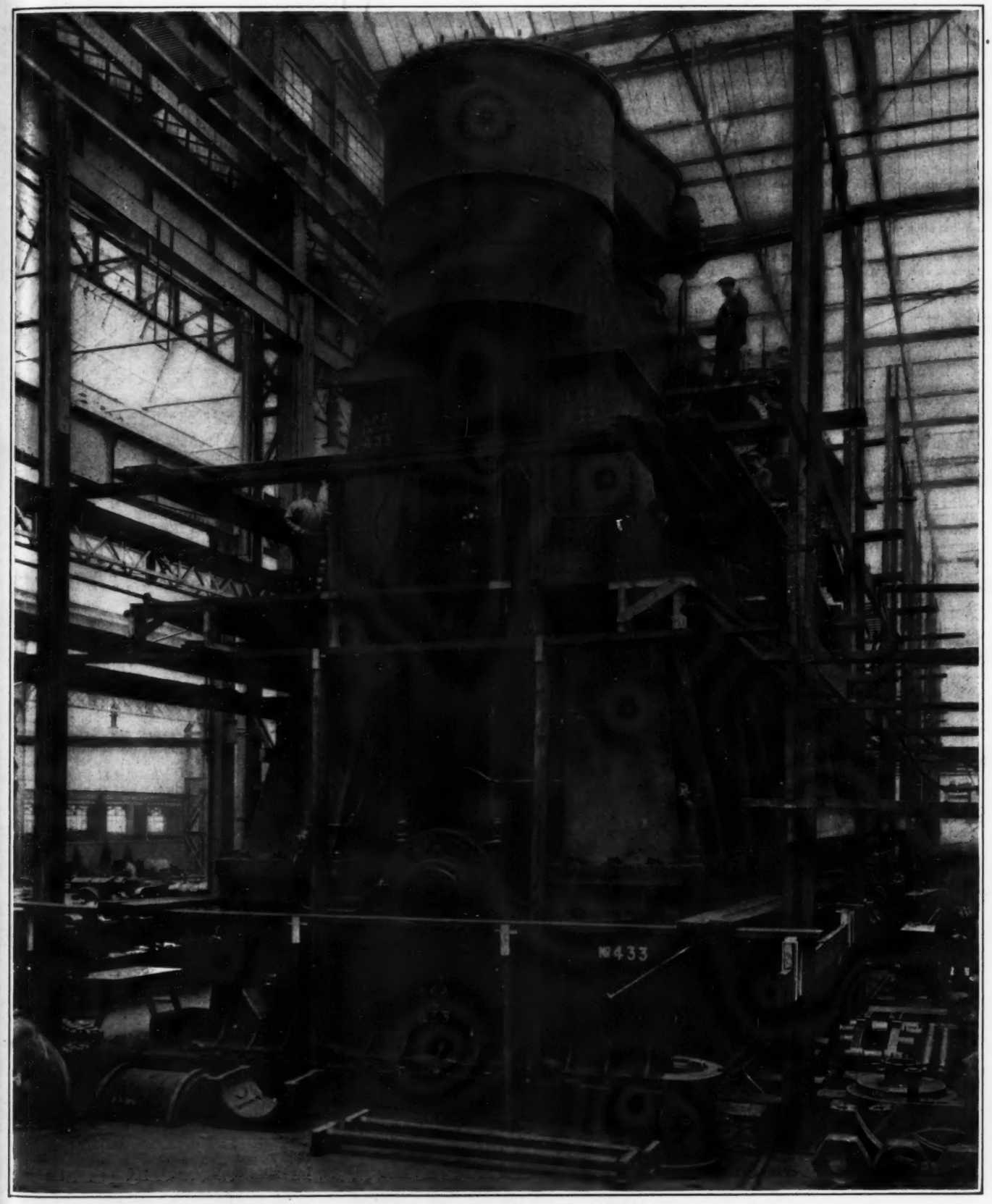


One of the sets of reciprocating engines in the shop.

THE TRANSATLANTIC STEAMER "BRITANNIC."—[See page 170.]

The Industrial Need of Technically Trained Men

The Career of Marine Engineering

By J. C. Workman

Mr. J. C. Workman, the author of the following article, is Chief Engineer of the American Shipbuilding Company. He began work in the machine shop of the William Cramp Ship and Engine Company, at Philadelphia, some 26 years ago. From gang foreman in the shop for 2 years, he went into the drafting room of the engineering department.

In 1897, he went to Cleveland to work on revenue cutters for the Globe Iron Works, of which he was made chief draftsman a year later. When the American Shipbuilding Company was formed in 1899, taking over several companies, including the Globe Iron Works, he was made chief draftsman of the combination. In 1911, he was made its chief engineer.

Mr. Workman obtained his technical education at Franklin Institute, Philadelphia. He is a member of the Cleveland Engineering Society.—EDITOR.

THE question as to whether a college education is essential in marine engineering has been very thoroughly discussed by Messrs. Carnegie and Crane. My own opinion, after some 26 years in the business, is that it all depends upon the man. However, the man with the college education will make more rapid progress, than the man who, after his days work is over, has to grind over his books with a tired brain. The company with which I am associated always shows a preference for college men, or at least boys with manual training experience.

However much experience the so-called self made or practical man may possess, he is constantly compelled to consult the scientific or college man, on many difficult and perplexing problems which can only be worked out by the technically trained mind.

The marine engineer must naturally have a mechanical mind. He should have an analytical mind, and be able to reason out cause and effect. He should cultivate the power of observation and concentration and must possess a good memory. This is most essential. He must have courage, as often he will have to accept great responsibilities, involving large undertakings that may stand or fall, depending upon his engineering ability.

Often he is compelled to attempt new feats in engineering for which he can find no precedent or data in the text books, but must use his own ideas, based on common sense and experience. This remainds me that one of the most prominent marine engineers of the East once remarked: "Never let your engineering get away with your common sense. Engineering is only common sense."

From the crude little "Clermont," of 1807, called "Fulton's Folly," which took 32 hours to make the first trip up the Hudson from New York to Albany, to the great German liner "Imperator," with her vice admiral, 4 captains, crew of 1,000 men in an enormous hull 918 feet long, 98 foot beam, 57,000 tons displacement on load draft, propelled by turbines of about 65,000 horsepower, combining speed with the most luxurious appointments and conveniences for her passengers, is the progress of merchant marine.

From Perry's flagship, the "Niagara," built of green lumber, with her primitive armament, to the 30,000 ton modern battleship with her battery of 12-inch guns, and protected by the best steel armor from 12 to 18 inches thick, is the story of the wonderful achievement of naval engineering of a century.

The young man who decides to take up marine engineering as a profession will find it most fascinating in either of its braches, hull design or propelling equipment and auxiliaries. So many beautiful engineering problems to work out, and such a variety—no two jobs alike—all vessels designed to meet the special requirements under which they are to operate.

First there is the fresh and salt water classification, the deep draft and light draft type, the latter in use on shallow lakes and rivers, and usually of the side or stern wheel types. These are seen on the Ohio and Mississippi rivers. Many of this type have been built in the United States for South America, such as the steamer "Mamore." There have recently been built at Port Arthur, on Lake Superior, two very fine steamers of this class, to ply on the Kootenay Lakes of British Columbia. These boats run on a draft of 4 feet six inches and make 22 miles an hour propelled by light tandem compound engines working under 200 pounds pressure per square inch, and developing 1,200 horse-power. A unique feature in the construction of these boats is the fact that they were completely built at Port Arthur, and then shipped in a knocked down condition by rail to Nelson, B. C. The first of these steamers is the "Nasookin," 227 feet over all, 40 feet beam, 8 feet deep.

The stern wheeler lends itself particularly to shallow lakes or rivers because it can be so easily steered. Usually it has two rudders, and the flow of water from the wheel against the port or starboard rudder alternately, causes the boat to come about very quickly.

Before the type of a ship can be determined, there are many preliminary investigations to be considered. The boat must be designed to especially meet the conditions of her trade. The owner or manager usually knows his own business, and can be of great assistance to the naval architect or designer in deciding the best arrangements of cabins, cargo space, carrying capacity, draft, etc., and the most desirable machinery.

Then there is always the business side to be considered. Though an undertaking may be a complete engineering success, if the financial part is not satisfactory, there is small credit for the engineering end. It may have failed through lack of proper supervision in the shop or on the field, or it may have been that the designs were expensive from a machine shop point of view. A little more consideration in the drafting room might have saved the profit.

Among the most prized possessions of engineers are their private note books. Text books and treatises are great helps to them but the personal notes and sketches of good details, the results of personal experiences jotted down from time to time, also well tried formulæ and results of tests that they have from their own knowledge secured and know can be depended upon, are of the greatest value.

The marine engineer must have a good idea of electrical engineering, as this equipment is becoming more and more of a necessity on shipboard and is likely soon to be used on all auxiliary machinery. The electrical apparatus on warships and big liners is enormous, the cost of electrical equipment on one of our latest battleships was $300,000.

Ship ventilation is being widely used. Refrigeration has become another important feature in the equipment of vessels. All passenger steamers and the better class of freighters have their own refrigerating plants. Refrigeration has revolutionized the method of carrying perishable goods such as beef and fruit. Steamers especially designed for this trade are marvels of engineering skill. Sanitary and hydraulic engineering figure largely in the design of a modern passenger steamer.

The Diesel oil engine, or the internal combustion motor, has opened up a new and interesting field for the marine engineer. While so far, not very much has been accomplished in this country, a great industry has been developed abroad, and a large fleet of Diesel propelled vessels are in the commerce of the world. Tankers up to 15,000 tons displacement are being built with this type of motor, as well as some German warships. At present there are but two of any size being operated on the great lakes, the "Calgary," of about 700 horsepower, and the "Fordonian," of 900 horse-power, both of these are foreign constructed vessels and Canadian bottoms.

The chief difficulty for the Diesel motor in the United States, where coal for marine purposes is so cheap, is the uncertain supply of crude oil or petroleum which cannot at present be satisfactorily or regularly procured at a reasonable price. If this were not so, I can see no reason why this method of propulsion would not rapidly supercede the present steam engine. The principal advantage being economy in operation as regards the amount of fuel consumed which is only about four tenths of a pound per horse-power, while the coal consumption is from one and a half to two pounds. A smaller engineering force, the weight and space gained by doing away with the boilers and coal bunkers, convenience of fueling as it requires no trimming, the radius of steaming under one fueling, the saving of fuel while the vessel is in port and many other advantages that might be mentioned.

So the young man who thinks of undertaking either branch of the profession of marine engineering and ship building will find he has to have a good broad education and a good general knowledge of many of the branches of engineering.

I have always contended that the finished marine engineer could, with a little preparation, undertake most of the other branches such as civil, hydraulic, electric and others, because of the elasticity of mind required to meet the diversified problems that come up in many years experience in the ship yard and shops.

The opportunities in this country for the marine engineer are many. If he wishes to follow the profession of a designer, he will find ship yards of more or less importance on nearly all the rivers and lakes from Maine to California. If he wishes to follow the sea, there was probably never a greater demand for young men of education than now. On our own lakes good men are needed. The old type of engineer is fast becoming a thing of the past and our big steamship companies are looking for men of engineering education. They find it pays to have their investment in the hands of men who understand the theory of it all, as well as the practical end. Some of them have established winter classes for the betterment of their men.

The remuneration for this type of men is very good, and exceeds the average office man by far.

In conclusion, let me emphasize the importance of having at least most of the qualifications that have been spoken of in this article. Unless you are a born engineer, you are not likely to be a success as I have been taught to measure success.

A Novel High-Tension Voltmeter

ACCORDING to the *Elektrotechnische Anzeiger*, as quoted in *Die Umschau*, the firm of Siemens and Halske has patented a high tension voltmeter which makes use of that peculiar phenomenon of electrostatics which is known as the electric wind. This phenomenon is usually exhibited with the aid of the electric vane shown in Fig. 1. A vertical metal rod, bearing at its top three or more horizontal spokes with their pointed tips bent at right angles, and all turned in the same rotational direction, is mounted on an insulated tripod in a socket which allows it to rotate with little friction. When the socket is connected with an electrical source of high potential, such as an induction coil or a static electrical machine in operation, the vane is set into rapid rotation, in the direction opposite to that in which the spokes are bent, as is indicated by the arrows in Fig. 1.

The following explanation of this phenomenon is given by J. J. Thomson. Air and other gases possess very little electrical conductivity, so that the production of an appreciable current requires a very high tension. In these conditions the ions, which are the carriers of the electricity, attain so great a velocity that they shatter the molecules with which they collide, and thus produce new ions. When a great many ions have been produced, a discharge takes place at sharp points of the charged conductor. This brush discharge, as it is called, is visible in the form of a sheaf of luminous rays of measurable length. At the end of the brush is an accumulation of ions, which, being repelled by the electrified point, set the surrounding air in motion, and thus produce the electric wind. The resulting reaction drives the conductor, if it is movable, in the opposite direction.

Fig. 1.—Electric vane for demonstration of the electric wind.

The designation electric wind implies that the discharge acts like a stream of air expelled from the electrified point. If tobacco smoke is blown against a sharp point connected with the conductor of an electrical machine, the smoke is carried away by the electric wind. The flame of a candle, held near the point, is blown over (Fig. 2), and the pressure of the electric wind can be felt by the hand. These facts indicate that the electric wind possesses a high velocity. M. Holtz, the inventor of the static induction machine which bears his name, measured the deviation of a vertical plate suspended athwart the air current, and deduced a velocity of about

8 feet per second for the electric wind. Other experimenters have measured the speed of rotation of the electric vane, and have found it proportional to the strength of the discharge current, which is proportional to the electric potential of the vane. Hence the potential of the vane can be deduced from its speed, and the vane can be utilized for measuring the tension or voltage of the source of electricity with which it is connected.

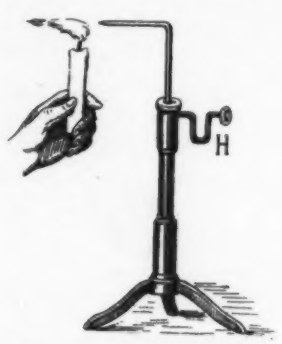


Fig. 2.—The effect of the electric wind on a candle flame.

In the new high tension voltmeter, the electric wind is employed indirectly, for the production of an air current by aspiration. A diagram of the apparatus is shown in Fig. 3. The electrical source whose tension is required is connected by the binding screw *Kl* with the insulated metal point *Sp*, which stands in the axis of the vertical tube *R*, which is open at the bottom. The electric wind produced by the point *Sp* sucks air through the tube *R* and drives the combined current through the curved tube *C* against and past the *loosely* fitting piston *K*. The piston is connected by a curved rod to the free end of the rotating arm *H*, which, impelled in one direction by the pressure of the air current on the piston, and in the other direction by the spring *F*, assumes a position which depends on the tension of the source which produces the electric wind. The pointer *Z*, attached to the arm *H* moves over the scale *Sk* which is graduated to give the tension of the source directly in volts.

For the measurement of very high potentials, the new voltmeter is certainly simpler and more convenient than electrometers based on the attraction or repulsion of two charged conductors. Even in technical high tension work it may be found advantageous to substitute the new voltmeter for the instruments now employed, which, in almost all cases, are low tension voltmeters connected with the high tension wires through transformers. The high tension voltmeters now in use are employed chiefly in testing insulation.

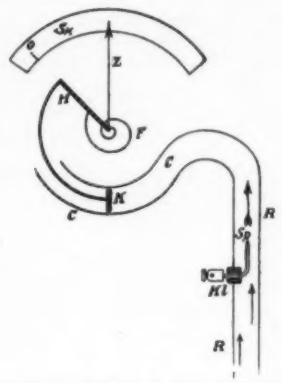


Fig. 3.—Diagram of the Siemens & Halske high-tension voltmeter.

Chemistry in 1913

GREAT discoveries, fruitful hypotheses, generalizations at once comprehensive and sound do not occur necessarily in the arbitrary period which we call the year, and no disappointment need be felt because in the past twelve months there has been nothing of such a kind to record—with an exception which will presently be reached. But there has been the usual steady stream of the results of work, much of which has been directed by great knowledge and high intelligence, the ultimate value of which may prove of the best, and whose present worth is considerable, as closing some of the gaps in a science which consists chiefly of such inconvenient vacancies.

For example, a good many new substances of intrinsic interest have been prepared, and will go into the chemical catalogue with their nature and properties duly tabulated for the benefit of the future investigator. Boron hydride, B_2H_6, is obtained by the slow spontaneous decomposition of the hydride B_4H_{10}, the decomposition being hastened by the action of ultra-violet light or by a temperature of 100 deg. Cent. It is a colorless gas with a repulsive smell, and has a liquefying point of — 87 deg. Cent. and solidifies to long colorless needles at — 140 deg. Cent. Although boron nitride BN, has long been known, a new method of preparing it is worthy of mention. Boron trioxide, or borocalcite, is heated with carbon in an atmosphere of nitrogen in an electric furnace capable of use with pressures up to 500 kilos per square centimeter and temperatures up to 2,500 deg. Cent. The yield increases with the pressure, and when this is fairly high—e.g., 70 kilos per square centimeter —may be as much as 85 per cent of the calculated quantity. The chief practical interest of boron nitride is its possible applicability for providing a means of preparing nitrogen compounds useful in the arts.

Carbonyl cyanide, $COCy_2$, analogous to carbonyl chloride, $COCl_2$, is prepared by exposing carbon monoxide and cyanogen to the ultra-violet light of the silent electric discharge. It is a yellow solid, evidently a polymer of the simple molecule $COCy_2$.

Further investigations of the analogies which exist between carbon and silicon and between nitrogen and aluminium have been made, and a substance proposed to be called calcium silicalcyanide $CaSi_2Al_2$, has been prepared. It is regarded as analogous to calcium cyanide, CaC_2N_2, the silicon taking the place of the carbon and the aluminium the place of the nitrogen. It is a dark gray crystalline mass, readily attacked by hydrochloric acid and by alkalies. Osmium octafluoride has been prepared. It is a yellow crystalline substance melting at 34.5 deg. Fahr., and is of interest as proving that the metal can be octavalent.

A compound of carbon with oxygen, obtained by the removal of water from mellitic acid, has been prepared, and corresponds with the formula $C_{12}O_9$, and the suggestion is made that in the course of the combustion of carbon in oxygen, oxides other than CO and CO_2 may be formed. If any argument in this direction is to be drawn from the occurrence of substances containing carbon and oxygen by the progressive dehydration of suitable organic acids, it must be received with much caution, as the retention of an amount of hydrogen easily originating from that in the organic acid and in trivial quantity when measured by weight, would completely vitiate the assumption that the compound dealt with is an oxide of carbon; the assumption is of the same order of demerit as that anthracite, charcoal or coke is pure carbon.

Work on the volatility of metals of the platinum group has shown that platinum, rhodium and iridium wires disintegrate at high temperatures in air, and that their disintegration is conditioned by the formation of oxides of the type of PtO_2. Palladium, a metal of what may be called the lower platinum group, disintegrates by simple volatilization. In short, the former oxides are stable at high temperatures and the latter is not. Recent results for the melting points of refractory materials have been obtained by means of the optical pyrometer, and are: Chromic oxide, 1,990 deg. Cent.; alumina, 2,050 deg. Cent.; lime, 2,570 deg. Cent.; and magnesia, 2,800 deg. The melting point of alumina is also given as 2,010 ± 10 deg. Cent., but even with this error can be used for calibration purposes. Truly, an advance on the methods of fifty years ago when all were categorized as "infusible."

As an example of the need for close and cool examination of a simple observation, the following may be quoted: It was found that different specimens of distilled water acted with different speeds on sodium amalgam. The natural and too easy conclusion is that the water contained salts, which, splashing over in different amounts, acted as electrolytes in promoting the attack of the sodium. As a fact, it is much more probable that the difference of activity is due to the different amount of a volatile impurity, such as hydrogen peroxide, which in minute quantity may be formed during distillation, although there may be other causes.

The exception to this prosaic record mentioned in our opening paragraph is the announcement of the presence of neon in hydrogen after the passage of an electric discharge there-through at low pressures, which has led to the surmise that conversion of hydrogen into neon may occur. The mode of operation was briefly this: The purest hydrogen was submitted to the electric discharge in a vacuum of the X-ray order. The gas left in the tube was analyzed by explosion with oxygen, and the excess of oxygen was absorbed by charcoal. The residual gas was sparked, and its spectrum showed the presence of neon. Blank experiments showed the absence of neon when the hydrogen had not been sparked. Evidently the most likely cause of error is the incursion of air which contains neon. To test this point, the tube was surrounded by another which was filled with helium. On sparking the inner tube, neon was found as before, but no helium with its characteristic spectrum could be detected. It is a fair conclusion that the origin of the neon in the sparked hydrogen was not due to the leakage of a gas—such as air—through the glass walls under the influence of the discharge. The next step was to abolish internal electrodes and to use an external coil of wire through which an oscillating discharge was passed. In this case, helium and some neon could be detected in the hydrogen. Another trial was made, using a vacuous tube and electrodes passing in glass envelopes through this into the inner tube. Again, helium and some neon was detected. (It will be noticed that in the earlier experiments mention is made of neon only, and that in the later helium also was found.) In addition, carbon was found in the capillary tube between the two ends of the inner tube, and it is a general experience that when a gas has been treated by electrical discharge and might be expected to contain only hydrogen with traces of neon and helium, it also gives the spectrum of carbon, which disappears after sparking for some time.

We have gone into this matter at some length at the risk of being tedious, with the purpose of insisting on the great experimental difficulties, the great care and skill which have been exercised in the endeavor to overcome them, and the fact that they are inconclusive as to the production of neon and helium from hydrogen, although they lend support to that view. A conclusion of this kind is so momentous that the utmost caution must be observed in scrutinizing evidence based on the treatment of minute quantities of material in apparatus relatively large and by forces which may have unforeseen effects on the materials of which the apparatus is constructed.

Quite a respectable list of radioactive elements—ranging from Thorium *B* to Ionium—have had their valencies determined by a diffusion method, and are assigned values from 1 to 4, just as if they were our humdrum old friends silver and tin.

The latest gas obtained electrically is X_3, produced together with helium when metals and salts are bombarded with cathode rays. It is inert, refusing to combine with oxygen, phosphorus or sodium, but can be caused to unite with mercury by an electric discharge and combines to some extent with red-hot copper.

Cryoscopic methods have been used to steady the phenomena of neutralization, and in general confirm the basicity of acids as determined by ordinary indicators, although in special cases the cryoscopic method may have a use of its own.

The relation between crystalline structure and molecular volume is still a matter of discussion, and rival theories are in the field.

A little organic chemistry may not be amiss after this. Phenyl-diphenylyl ketone when treated with potassium forms the derivative $C_6H_5.C_6H_4.C(OK).C_6H_5$ in which the carbon should be tervalent. The name proposed for these bodies is metal ketyls. By the action of nitrogen iodide a substance itself of disputed composition—on ketones containing a methyl group, tri-iodomethyl ketones are formed, which in the presence of the ammonia simultaneously set free are hydrolyzed, giving odoform and an amide. Organic nomenclature is improving, if one can trust *Punch*, which says: "From a notice of the Chemical Society's publications: 'Conversion of ortho-nitroamines into oxadiazoleoxides (Furaneoxides).' The explanation in brackets is perhaps hardly necessary, but it may be welcomed by some of our more ignorant readers." Of course, *Punch* may have made a slip.

Ammonium peroxide $(NH_4)_2O_2$, corresponding strictly to sodium peroxide, Na_2O_2, has been prepared, but is not stable above — 10 deg. Cent.

Beryllium has been obtained by the electrolysis of its fluoride, and has a specific gravity of 1.842, a melting point of 1,280 deg. Cent., and does not volatilize at 1,900 deg. Cent. These qualities are in accordance with its resemblance to magnesium, and further distinguish it from aluminium to which it was once supposed to be cognate.

The corrosion of metals and means for its prevention is of such importance that it must claim a place in this review, although nothing very striking or definitive can be adduced. Naturally, the corrosion of iron takes first place, and on the whole the electrolytic theory holds its ground in the sense that the want of homogeneity of the metal is the chief cause of its destruction. Experiments on electrolytic iron, still relatively impure, containing not less than 0.033 per cent of alien substances, prepared for a totally different purpose, namely, the determination of the points at which iron is supposed to change its physical state, would have been useful, but those which have been done relate to industrial materials whose composition is too complex to allow of more than empirical deductions. A little more has been done with the alloys of copper and zinc, with some small addition such as tin, and in the case of tubes for condensers it seems that the Admiralty alloy—copper 70, zinc 29, tin 1—is to be preferred, but the chemical cause of this superiority remains unknown. We are afraid that as long as common metals are oxidizable, corrosion problems will abound, however carefully alloys may be devised and prepared.

An obvious corollary to this problem is how to protect such common metals, and as lead paints are freely used for iron, it is interesting to note that they have been attacked on hygienic grounds, and a bitter controversy has arisen. The record of the leadless glaze campaign goes to show that mental plumbism is not uncommon, and on the evidence before us it appears more likely that no volatile lead compounds are given off by lead paints while drying, and that whatever toxic effects may occur are caused by the organic substances generated or volatilized in that process.—*The Engineer.*

How the Weather Bureau Forecasts Storms, Frosts and Floods*

MANY people have an idea that there is something mysterious and occult about the work of the Weather Bureau in forecasting the coming of storms, frosts and floods. Not a few think that the observers must necessarily get their data by reading the planets, the stars and the moon. As a matter of fact, the forecaster of the Bureau foretells the coming of disturbances in a business-like way, very similar to that in which a man who has ordered a shipment of goods would estimate the date of its arrival.

Suppose a business man had ordered a carload of pineapples from the Hawaiian Islands. He would know the average time it would take the steamer to make the trip to the Pacific port, the average time for unloading and loading into refrigerator cars, and the average number of days to be allowed these cars for their trip across the continent to New York. His estimate, however, would be subject to error, because the steamship might be delayed by fog or the cars meet with an accident.

Storms, like pineapples, as a rule, do not originate in the United States. They come to us, some from the Philippines, Japan, Siberia, Alaska, Canada or the Gulf of Mexico. The Weather Bureau gets cable, telegraphic or wireless notice of a foreign storm. Station after station, or vessel after vessel reports the storm's arrival in its neighborhood, so that the general direction and rate of progress can be determined very early. In fact, the arrival of some storms can be foretold ten days in advance.

The forecasters watch for the region of low barometer which is the storm center around which the winds blow. This whirl or eddy moves bodily forward with the general eastward drift of about 650 miles a day in our latitudes. The forecaster determines the direction of movement of the storm and its velocity.

When weather disturbances are reported, the forecasters know from experience about how long it takes them to reach our Pacific Coast, and then how long after they will reach the Atlantic Coast. For example, if a storm coming from Siberia drifts eastward around the North Pole and reappears in Alaska, it should appear in Washington and Oregon in about two days; should get to the Great Lakes in six days and to the Atlantic Coast in seven or eight days.

Unexpected conditions may delay storms or divert them from the straight track, just as a refrigerator car may be thrown off its schedule or be shipped by accident on a wrong road. Some of these storms deplete themselves by running into regions of high barometer which are of greater magnitude and extent than the storm itself. Some of them, however, travel completely around the world.

To keep tab on cold waves that come into the United States from Canada and Alaska, the Weather Bureau studies the Canadian Weather reports. England sends reports from Iceland, the British Islands and continental Europe, and daily reports come from St. Petersburg on the conditions in Russia and Siberia.

The same business-like system used in tracing the track of a storm is applied in determining the arrival of frosts.

Flood forecasts are made in much the same way. Information as to the amount of rainfall at the head waters of streams that cause floods are covered by telegraphic reports sent by local observers. As this rain reaches the main channel, the height of the water in the channel is determined by successive gaging stations. Past records establish how much a height, say, of 20 feet at Dubuque, Iowa, will produce at Davenport, another station 80 miles down the Mississippi. This plan is followed all the way down the river, and at each point full allowance is made for the effects of water from tributaries, and from additional and local rainfall. As a result of these observations in the recent flood, the people of Cairo had warning a week or 10 days in advance. The Pittsburgh district can be given only 12 to 24 hours' notice, because a flood is upon them within 24 hours after a heavy rain storm.

* *Weekly News Letter* of the Department of Agriculture.

The Civilization of the Hittites of Syria*

Excavations at Carchemish

By D. G. Hogarth

THREE years ago the Trustees of the British Museum undertook what has proved the largest, and in many respects the most important and fruitful, excavation which they ever promoted. Three years have seen six campaigns in the soil on which there is no reasonable doubt once stood Carchemish, the leading city among the Hittite peoples of Syria. Mr. C. L. Woolley, well known for his Nubian researches, and Mr. T. E. Lawrence, who worked under Mr. Thompson and myself, have been in charge for the most part of this time, carrying on the excavation for a spring season and an autumn season in each year with between two and three hundred men. They have had their difficulties, and even their dangers, for Jerablus lies in a lawless region, among Kurdish tribes excited by recent events in Turkey; but they have faced and surmounted them with courage, persistence and signal use of the faculty which so many Britons possess for gaining the confidence of wild fighting folk. By the end of next spring season the Trustees, who have been splendidly supported by private munificence, will have expended some $50,000 on the site; but the work, which is opening up Hittite history for us, and the nature of the civilization occupying the geographical space between the Semites and the Hellenes, will not be much more than half done.

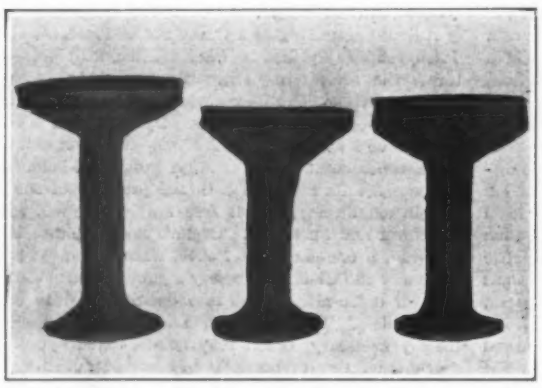
The site consists of what is called a "royal city," that is, a strongly fortified enclosure containing palaces and their appurtenances, with a citadel, and an unfortified area inhabited by the commons. It is the first which is being explored. Its ring-wall, which enclosed about half a square mile on the bank of the Euphrates, has been stripped away to build a later town; but the huge mound on which the wall stood still remains, rising from the moat to a height, in places, of nearly fifty feet. Also three gates remain, of which two have been explored. Here, under Hellenistic and Roman structures, the explorers have laid bare remains of Hittite buildings, consisting of flanking towers and successive lion-guarded portals, one within another, divided by open courts, in each of which an enemy, breaking in, would have had to encounter flanking fire. The fine masonry of the southwest gate is well shown in one of our views, in which the spectator looks outward over the plain on which Nebuchadnezzar settled accounts with Pharaoh Necho in 605 B. C. Now it is diversified by the line, sheds and other constructions of the Baghdad Railway. In excavating this gate, the explorers found a fine head of a god or king of the latest Hittite Age, when, in the seventh century B. C., perhaps, the lords of Carchemish were Aramæan Semites. The back of the head of the God or King shows the turban-like covering worn by the figure. The North Gate, of still more elaborate construction and plan, is still under excavation.

Within the walls a large complex of Hittite palatial buildings has been partially cleared, together with a water-gate on the river bank which was flanked by great lions in dolerite, inscribed with Hittite hieroglyphic texts. The westernmost member of this complex is a large building entered by a portal from both jambs of which run, as far as the clearance has yet been made, dadoes of sculptured slabs, alternately of black dolerite and white limestone. The finest reliefs, those on the façade of the portal itself, show two men, probably two kings, one being an ally, followed by eight children, of whom the last still totters, holding to a staff, and a baby in the arms of a woman, who leads a pet animal. She should be the queen, who appears nowhere else in the group. The children throw knuckle-bones or carry whipping-tops according to sex and age. In front of the whole group is a hieroglyphic inscription, the longest known, which, with the legends graven near the head of each member of the group would tell us who they all were, could we read the script. We can, however, guess safely that it is a royal group of about the ninth century B. C.

The style and execution of these reliefs upset all our previous ideas about the quality of Hittite art; as do also the sculptures which line the opposite side of the portal—royal ministers and servants in whose delineation has been used a grace which is almost Greek. Of the soldiers who follow them—note their "Carian" helmets, as the Greeks would have thought—of the long file of priestesses and acolytes bearing animals for sacrifice, of the slabs of mythologic scenes beyond the soldiers, and of the other inscribed inner doorways, we can give only two or three specimen views. As excavation proceeds, this great series of sculptures will no doubt be found to be prolonged at either end.

From this building a wall, also bearing reliefs along all its length, runs up to a great staircase, which climbs up the face of the Acropolis, and is (or was) lined with sculptures of which some are still in position. To the left is another building of the palatial complex built on the terraced slope. Here was found a small, shrine-like chamber with elaborately inscribed portal, before which stood a great laver, supported, like Solomon's, by two bulls, which are shown in one of our views.

On the Acropolis the remains are less well-preserved because in Roman days a great temple was built there, whose foundations almost destroyed the large brick buildings of the Hittites. At the north end, too, Sargon the Assyrian, who captured Carchemish in 717 B. C., built a residence for his officer. This has been cleared and its remains appear in one of our photographs, which



Probably of between 2,000 and 1,500 B. C. Vases of the peculiar form characteristic of the early cist graves.

Found on the citadel of the strongly fortified "royal city." A column base supported by two lions.

(By courtesy of the *Illustrated London News.*)

From the dado of mythologic slabs. A human and lion-headed sphinx with tail ending in a bird's head.

* Reproduced from *Illustrated London News* together with all illustrations.

looks northward up the Euphrates. But the Acropolis has yielded a most important set of early tombs, with which we can now compare the contents of another cemetery outside the walls.

From Jerablus and its neighborhood we have a long series of graves wh'ch show us the pottery and implements and seal of the Syrian Hittites from about 2,000 to about 400 B. C.; and when it is said, in conclusion, that the stratification of the city site gives us orderly evidence from the Neolithic Age to the close of the Bronze Age; that the development of Hittite plastic art can now be studied from its cradle to its grave; that the same is true of the hieroglyphic script, of which over a hundred new texts have come to light; that we have cuneiform inscriptions already, and may at any moment get a bilingual key to the hieroglyphic puzzles—when so much can be said for three years' work on a part only of this great site, it is well worth digging completely.

Fig. 1.—With armament recalling that which the Greeks believed they derived from Asia Minor. Soldiers of the ninth century; from the "King's" gate.

Fig. 2.—At the "King's" gate. The royal group; probably two kings, one being an ally, followed by eight children, and a woman (possibly the queen) carrying a baby and leading a pet animal—of about the ninth century B. C.

Fig. 3.—Perhaps of the twelfth century B. C., and one of the earliest reliefs found at the water-gate. A scene of sacrifice.

Fig. 4.—In ninth century style. Three acolytes bearing animals for sacrifice.

Fig. 5.—Seen from the citadel above the great stairway. The area of excavations at Jerablus, the site of Carchemish.

Fig. 6.—Looking toward the Euphrates down the valley which protected the city on the north side. The citadel of Carchemish from the northwest.

Fig. 7.—Marching to meet the royal group at the "King's" gate. Ministers and soldiers.

Fig. 8.—The longest known hittite hieroglyphic text. The great inscription in front of the royal group at the "King's" gate.

Fig. 9.—Possibly eleventh century. An inscribed door-jamb of the earlier palace.

Fig. 10.—From the court before the shrine. The great laver supported, like Solomon's, by two bulls.

Fig. 11.—From the dado of mythologic slabs. The hunter-god.

Fig. 12.—From the dado leading to the "King's" gate. Priestesses and Acolytes.

Fig. 13.—Inscribed with name and titles in the Hieroglyphic script, which no man can read. A bearded god of Assyrohittite style (eighth century B. C.?), seated on a base supported by two lion s led by an eagle-headed figure.

By courtesy of the *Illustrated London News*.

Wireless Telegraphy*

Signals By Means of Hertzian Rays Made Before Marconi's Practical Success

WHEN Mr. Marconi first came over to England in 1896, Mr. Swinton was the means by which he was introduced to Sir William Preece, and the latter, having just then come to the conclusion that his methods of inductive and conductive telegraphy—with which he had been attempting to effect communication with lightships—were unworkable, set the Post Office to work with Mr. Marconi, Sir John Gavey having charge of the experiments. It might seem strange, as Prof. S. P. Thompson had pointed out in *Nature*, that Sir William Preece missed the possibilities of Sir Oliver Lodge's Hertzian-wave experiments, but took up Mr. Marconi with practically the same system. But Sir William Preece had always been particularly sympathetic to the young, and Sir Oliver Lodge had not approached him directly.

Next, quoting from an article which Sir William Crookes contributed to *The Fortnightly Review* in 1892, Mr. Swinton showed that Sir William Crookes had in those days fully realized the possibility of telegraphy by means of Hertzian waves. He clearly described how messages might be sent in Morse alphabet by means of apparatus tuned to special wave-lengths and receivable only by apparatus similarly tuned. Mr. Crookes also referred to experiments made by Prof. Hughes in 1879, where wireless signals were transmitted over several hundred yards, at which experiments he had assisted. There seems to be no doubt that Hughes discovered Hertzian waves and noted their effects some years before Hertz rediscovered them, but, unfortunately, Sir George Stokes told Hughes, apparently quite erroneously, that the results could be explained by known induction effects, and Hughes was so much discouraged that he never published anything on the matter.

Then, with reference to Sir Oliver Lodge, Mr. Swinton said that he would always regard him as the original inventor of wireless telegraphy, because Sir Oliver Lodge in his Royal Institution lecture in 1894, and later at the Oxford meeting of the British Association in the same year, had first publicly sent signals, rung bells and deflected galvanometers over a distance by means of Hertzian waves. It had been said that Sir Oliver Lodge did not make clear the telegraphic application of his experiments, but Mr. Swinton was present at Lodge's Royal Institution lecture, and was so much impressed with the telegraphic capabilities it suggested, that he had next morning discussed with his then assistant, Mr. J. C. M. Stanton, the possibility of setting up communication between his residence in Jermyn Street and his office in Victoria Street by Lodge's method. This experiment was never tried, as they had thought that too many large buildings intervened, but preliminary experiments were made in Mr. Swinton's office, and signals on a bell were successfully transmitted and received through several walls with a large Tesla high-frequency coil used as transmitter, and as receiver a coherer consisting of a heap of tintacks. This was two years before Mr. Marconi arrived in this country, but in making these statements Mr. Swinton did not wish in any way to belittle the great work that Mr. Marconi undoubtedly accomplished in making wireless a practical and commercial success by long-continued and arduous labors.

Passing to his experiments, Mr. Swinton stated that finding a difficulty in reading wireless messages by ear, he had devoted attention to automatic recording apparatus. A simple arrangement that he had devised was to employ a sensitive or manometric flame, such as can be made exceedingly sensitive to minute sounds, the flame greatly shortening and roaring the moment the smallest sound reaches it.

Different descriptions of these flames respond more readily to sounds of different pitches, and they also can be tuned to some extent, so that different flames would discriminate between signals of different acoustical pitch even of the same electrical periodicity. All that was necessary was to place the receiving telephone in proximity to the sensitive portion of the apparatus producing the flame, and if a screen were placed in front of the latter hiding the flame when it was shortened, photographic records of Morse signals were easily obtained by throwing by means of a lens a small image of the flame when visible upon a moving strip of photographic paper. Another method of recording the signals employed by the lecturer was to arrange a quick-period mirror galvanometer with the movable portion oscillating between adjustable stops, the oscillations being recorded on a strip of moving photographic paper by projecting on the latter the reflection in the oscillating mirror of a bright point of light proceeding from a pinhole in an opaque box, containing an electric lamp.

Operating, as he did, at his own house, with a very small aerial, Mr. Swinton, in order to magnify the signals, made use of several relays of the types invented by Mr. S. G. Brown. He showed three of these relays connected in series, actuated by signals received on a temporary aerial that Messrs. Gamage had kindly erected on the roof of the Institution of Electrical Engineers. The relays operated a Kelvin siphon-recorder, as well as a loud-speaking telephone, which could be heard by everyone present. At a quarter to nine o'clock a special congratulatory message was received. This was sent by Commandant Ferrie, a vice-president of the society, from the Eiffel Tower. Not only could every signal be clearly heard throughout the Lecture Hall, but it was also received on the siphon-recorder. Further, the motions of the siphon were made visible to the audience, being optically projected on a screen with the aid of an epidiascope, kindly lent by Messrs. Leitz & Co. The dots and dashes were easily read, both audibly and visibly, though the Admiralty in London was accidentally during part of the time sending radiotelegraphic signals, which were likewise made audible by means of the loud-speaking telephone. The message from the Eiffel Tower consisted of thirty-four words, and occupied about seven minutes. A congratulatory message was also received and rendered audible to the audience from the London Telegraph Training College at Earl's Court.

Mr. Swinton also showed the working of an ordinary Morse inker by means of wireless signals from a distance. For this he employed the three Brown relays with a Siemen's Post Office relay in addition. The inker was modified by turning the magnets upside down, so that when energized they pulled the inking wheel away from the paper tape, and the signals were recorded when the magnets let go of the armature instead of when they attracted it, as is the usual arrangement. Mr. Swinton had devised this method to get over the difficulty of the extra current, due to the relay breaking the magnet circuit, sending a wireless signal back to the whole apparatus. With the modified arrangement this extra signal took place while the main signal was being received, so it could only accentuate the latter and do no harm, whereas before the modification was effected, when once started, the Morse inker went on working by itself like an electric bell.

Now the lecturer showed how it was possible to receive wireless signals on a phonograph. In the ordinary way, records made by this method were not loud enough to be heard by an audience, but a small microphone had been mounted on the repeating diaphragm, and connected by a loud-speaking telephone, and by this means signals from the Eiffel Tower and from the Admiralty, which had been recorded on the phonograph, were made audible throughout the hall.

Once an arrangement of relays that would work a Morse inker was provided it became possible to operat almost any kind of apparatus, and wireless signals se by the British School of Telegraphy at Clapham wer made, by means of the relays and an electromagnet, t work an air-valve in connection with a source of a pressure and an organ pipe, which latter gave forth i long and short blasts the signals of the message. Mr Swinton said that the same apparatus worked a motor horn very effectively, but the horn could not be use indoors, as its noise upset the relays.

Next it was explained how a Poulsen telegraphon could be used as a recorder; and that on the Poulsen Pedersen system an Einhoven "string" galvanomete was employed for this purpose. With this instrumen a signal containing energy to the extent of only on billionth of a watt could be registered, which is abou the same sensibility as what is obtainable with a Be telephone receiver. On the assumption that a 12 candle power light, radiating one watt in the form of visibl electromagnetic waves, was visible at a distance of fiv miles, and that the aperture of the eye was one fift of a square inch, then the amount of power reachin the eye would be about one sixth of one billionth of a watt, so that natural detectors like the eye, and artificia detectors, such as the Einhoven galvanometer, ha about the same order of sensitiveness, and were much more sensitive than any photograph process for in stantaneous effects, although photography had th advantage that cumulative effects could be obtaine by long exposure. Some years ago Lord Rayleigh found that the human eye and ear were of the same orde of sensitiveness.

Another matter mentioned by the lecturer was tha the Eiffel Tower aerial, as also those at Poldhu and a other large stations, gave out loud sounds when message were being transmitted, this being probably due to th air particles being electrified and repelled, as in a Brus discharge.

In his concluding remarks, Mr. Swinton speculated on the future of wireless. The chief difficulty at present with regard to wireless telephony is to get a microphone that would carry sufficient current without burning up, while there is also the necessity for switching over, when changing from receiving to transmitting, which renders conversation troublesome. These are, however, difficulties that should be got over, and it was probable that in the not far distant future we should have statesmen wirelessly addressing numerous audiences simultaneously, while wireless receiving stations would be set up in connection with halls where people would be able to go and hear *viva voce* all the prominent speakers of the day. Further, wirelessly operated column printing telegraphs would tell the latest news to all the nation, as also to any newspapers which continued to survive this much more rapid method of disseminating intelligence. Again, if we are ever to have transatlantic telephony, it would probably be wireless, with which the difficulties due to the capacity and self-induction of the cables are avoided.

Mr. Tesla and Prof. Pedersen even believe in the possibility of wireless transmission of power, and in this connection it must be remembered that practically all the power on our planet comes from the sun in the form of electromagnetic waves, and amounts, on a clear day, to no fewer than 4,500,000 horse-power per square mile of the earth's surface. This is, at any rate, good evidence that enormous amounts of power can be transmitted over prodigious distances by means of electromagnetic waves, but it is difficult to imagine how efficiency could be obtained.

Finally, Mr. Swinton appealed to the romance attendant on the spectacle of great liners hurrying across the ocean to the assistance of a ship from whom they had just heard in wireless whispers the S.O.S. signal of distress.

* Abstract by *Nature* of the presidential address delivered to the Wireless Society of London, on January 21st, by Mr. A. A. Campbell Swinton.

All Torpedoes!*

"ALL big guns!" has been our cry for the past ten years, prior to which the armament of ships consisted of many guns of small and intermediate caliber and only four of large caliber.

The reasoning that brought us to this policy, which in former years appeared strange but is now universally accepted, was similar to that which leads us to propose another radical reform in the armament of such ships.

At that time, the type of battleship was almost standardized, and there was such a perfect balance between the offensive power of the intermediate calibers with a few 305 millimeter (12-inch) guns and the defensive power of the very extensive light armor and the heavy armor in the most vital parts, that we assumed that there would be a very great expenditure of ammunition before a decisive victory could be gained by one of the two fleets engaged in a battle.

Everybody has made different deductions from the battle of Tsushima; but if the Russians had been in a condition similar to the exceptionally warlike condition of the Japanese, perhaps the results would have been different. Anyhow, we can state, in spite of the advocates of the intermediate calibers, that the battle of Tsushima showed the triumph of the new type of one-caliber ship.

We now find ourselves in a position similar to that of ten years ago. The offensive power and the defensive power are daily approaching equilibrium, requiring enormous displacements proportional to the increase of armor necessary for making up for the excess of power of the new guns.

If it should become necessary to increase the offensive power by further increasing the caliber, keeping twelve guns, it will be at the expense of the less important details in order to increase the thickness of the armor belt and the barbette to 400 millimeters (16 inches). But in order to avoid many other phenomena of the enormous tonnage, the number of guns, as their caliber increases, will be reduced from twelve to ten, or to eight; and this will be done in order to obtain, by adequate increases of armor, equilibrium between the offensive power and the indis-

*Translated by Lieutenant Thomas Withers, Jr., U. S. Navy, from *Rivista Marittima*, May, 1913, and published in the proceeding of the U. S. Naval Institute.

pensable defensive power of any well-designed ship.

But we are inevitably approaching the day when there will be nothing more to be done, and the naval architects will kill time in moving the little anti-torpedo-boat guns from place to place; and, perhaps, in the struggle to successfully excel themselves, they will increase the number or the caliber, changing from the manageable 76-millimeter (3-inch) to the heavy 152-millimeter (6-inch), which caliber is excessive for the light plates of the destroyers, and inefficient against the dreadnoughts at 10,000 meters.

As in the fashions some gentlemen keep pushing the characteristics of a type to exaggeration, until a radical change destroys their whole wardrobes at a stroke, so are we approaching the moment of the decennial change in naval fashions. In the meantime, the *new* weapon has made great silent advances, and now, perhaps, it can again reach the almost defenseless hulls and bring victory.

Defending a hull from torpedo craft is, in general, much more difficult than defending the above-water part from great guns. To defend a hull properly requires great, almost too great, tonnage; and in addition it takes up a considerable part of the interior of the hull, which is so necessary for boilers, engines and supplies. Therefore, we make the usual compromises and obtain a partial defense, which guarantees a ship against sinking upon being hit by a torpedo, but which makes it very difficult for her to continue the battle, even if she is not in a dangerous state of inferiority to the enemy.

This is, therefore, the great chance for the torpedo, which has made such progress in the last ten years, to show its offensive superiority against the poor defensive power of the hulls of the dreadnoughts.

Heretofore the torpedo has had three vehicles for bringing it to proper range and for launching it with success, and these are: the torpedo-boat, the destroyer and the submarine.

But all three of these are defective on account of the extraordinary lack of balance between the enormous offensive power of their weapon and their extremely weak defensive power, not only on account of the light plating of the hull, with a few little guns on it, but also on account of their increased size, which makes them easy to see and to hit.

Perhaps the submarine, or the submersible, will be able to reach a greater efficiency in the future if a lighter storage battery is found, and if there is invented some new motor that does not have to discharge gas as does the present electric motor, which on this account has such a limited radius of action and such a limited speed. For, if the route of the submarine is shown by the discharge on the surface, the ships with 22 to 28 knots speed will be able to avoid the attacks of a boat limited to running slowly at 8 or 10 knots, as at present.

Without analyzing the effective improvements in torpedoes or the new inventions that the Commission of Experiments[1] are trying out, which would take us too far from our short argument, we can state with certainty that to-day this arm is almost perfect, on account of its speed, its range, its accuracy, and, perhaps, even its offensive power against the net.

Since we do not stop to analyze the weapon, we will not stop to analyze its target, the internal protection of the hull, the use of nets, at anchor or under way, etc.

We wish to show only that the principal reason why this weapon has not yet been able to declare itself, like a gun, is the lack of a swift but well-protected carrier for it.

Attempts of every kind have always been made, as the experts know; and it is useless to record here the "Pietro Micca" and its other successors, or to enumerate their faults and defects. None succeeded in establishing themselves, perhaps because the moment was not opportune, as it is now, in this age of dreadnoughts, which are no longer increasing their great displacements; but we do not think that they will return to the type of the old "Inflexible" and "Duilio"[2] with but four enormous guns.

Nor did these attempts succeed in bringing about the triumph of the torpedo, and this was because it lacked the benefactor who knew how to handle it in a manner practicable enough to cause it to be considered by the experts, who are now so hypnotized by the big guns that they are blind to the weakness of the hulls against torpedoes. How is it possible to launch this new idea?

Let us proceed with a searching analysis. We attempt to bring the torpedo—which must injure, if not sink, the dreadnought—to a reasonable range. Therefore, the carrier of the torpedo must be opposed by the small or intermediate guns of the dreadnought, and also, in case of necessity, by the great guns, if these should come into action.

The water is a great aid to defense, but, as we have said, the submarines are slow, and must have a discharge to the atmosphere. We seek from the torpedo-boats their good quality, *speed*, and from the submarines their protection, *water*, but in combining these principal factors, we will give the submarine a discharge to the air which will increase its period of offensive action to more than the few hours that an electric motor at full power can give, and we will give to the destroyer a good protection against the small and the large guns of the dreadnoughts.

Two towers armored with about 400 millimeters (16 inches) of armor are placed almost at the extreme ends of the ship. Between these two towers are placed the two discharge conduits or stacks, the fresh air for the ship, and all that is inside of it, entering through an armored tube communicating with the outside.

For decreasing the resistance to motion, there is placed, forward of these towers, a cut-water of light plates, so light that they will probably not cause the enemy's shells to detonate. Then astern of the two towers there is another similar cut-water or wedge for the purpose of carrying the stream lines on up so as to keep the eddy water from coming on board. These structures, flared at the top, ought to decrease the pitching in a head sea, and the armored towers ought to furnish a good reserve buoyancy for the ship during and after the cessation of the battle.

The whole hull is submerged and the upper part is conveniently curved, like the deck of a submarine, and is sloped gradually into the bases of the towers in order to cut down as much as possible the resistance at high velocity in the trials of the model in the tanks. Therefore, in order to reduce the chances of damage to this surface, it is protected with sufficient armor which, in the vicinity of the bases of the towers and in the slopes around them, gradually increases in thickness, little by little, as the efficiency of the protection of the water decreases.

Inside of the hull, the forward part is entirely taken up by six torpedo tubes, three on each side, of the latest, most powerful type; next comes the forward motive apparatus, then another six torpedo tubes amidships, then the after motive apparatus, and then six torpedo tubes aft. With each broadside consisting of nine shots, the power of the vessel is very great on account of her ability to prolong the engagement until the complete, or nearly complete, destruction of the enemy's squadron.

As regards stowage space, these weapons and their launching apparatus occupy much less space than does the motive apparatus, which ought to give a speed of over 25 knots.

With a total displacement of 11,000 tons, this special warship has a sufficient margin for mounting eight 152-millimeter (6-inch) guns in each of the two towers, for making the destroyers, which could torpedo her, keep their distance, since these are her only dangerous adversaries.

These guns would not be manned in an action against dreadnoughts, this crocodile type having nothing to fear from either the small or the great guns of the dreadnoughts.

[1] A permanent board for experiments upon war material.

[2] The "Inflexible" was an old British battleship with a main battery of four 16-inch guns; the "Duilio" was an old Italian battleship with a main battery of four 17.7-inch guns.

Practical Processes for Producing the Best Permanent Magnets*

By Silvanus P. Thompson

To produce permanent magnets, which are both powerful and constant in their power, a tungsten steel should be used having from 5 to 8 per cent of tungsten, and from 0.4 to 0.6 of carbon. Chromium up to 2 or 2.5 per cent may be present, but the presence of the following elements should be avoided: manganese, titanium, copper, sulphur and phosphorus.

For bar magnets there is an advantage in having the dimension-ratio as large as possible, as this gives not only a higher permanence, but a lower coefficient of temperature variation. For horse-shoe magnets, and for all those which are to be used in instruments where extreme constancy is required, the gap between the poles should be as short as possible, and the polar areas should be as large as possible. From the point of view of constancy, there is an advantage in having a considerable stray flux (through a magnetic shunt or otherwise) in addition to the useful flux.

The forging of the magnet, whether bar or horse-shoe, should be done with as little working of the material as possible, and at as low a temperature as is convenient. After forging, to normalize the material it should be heated to 900 deg. Cent., lowered to 750 deg. Cent., and there maintained for a time, then cooled off. To harden the magnets, they should be raised to 950 deg. Cent. for a period not exceeding 5 minutes; and then lowered to about 700 deg. Cent., and quenched at this temperature in brine, or at a temperature under 20 deg. Cent. Some brands of high tungsten steel appear to yield a better result if quenched at some temperature between 770 deg. and 850 deg. Cent., or even at higher temperatures.

With tungsten steels there appears to be no advantage whatever in tempering the steel. With carbon steels there is no advantage in tempering the magnet if it is one having a small dimension-ratio (as for short bars). But bar magnets of carbon steel, if their length is as much as 20 diameters, may be tempered to a straw tint, or if as much as 40 diameters long, or more, they may be let down to a blue tint, and will then receive more magnetism. Any letting down below a straw tint, however, impairs their power to resist decay and usage.

The magnets should then be matured either by boiling or steaming them for 10 or 12 hours, or by heating them to 60 deg. Cent. for 20 or more hours. There is some advantage in letting them cool several times during this process. For a magnet that is intended to be used at some particular temperature, and is required to be as constant as possible at that temperature, there is some advantage in subjecting it to a number of cyclic processes of alternately heating it to a few degrees above, and cooling it to a few degrees below, that temperature at which it is intended thereafter to be used.

The magnet should then be magnetized by means of an electro-magnet, or, if a bar magnet, in a powerful magnetizing coil, to the highest degree of magnetization possible. There is some advantage in reversing its magnetism a few times. There is no advantage in magnetizing for a long time, as the result depends on the maximum magnetizing force applied, and not on the duration of the application. But in the final magnetization, the magnetizing current should not be suddenly switched off, but should be diminished gradually to zero. There appears to be a slight advantage in subjecting the magnet during magnatization to mechanical percussion, by striking it with a hammer of brass or other non-magnetic hard material.

For magnets that are to be given extreme constancy, there is an advantage in then slightly reducing their magnetism by subjecting them to demagnetizing forces, a reduction of from 5 to 10 per cent being sufficient. It is doubtful whether this process is necessary[1] for magnets the form of which is a closed circuit with a very narrow gap.

Just as the thermal stability of a magnet is best assured by subjecting it to small cycles of heating and cooling about the point of temperature at which it is thereafter to be used, so its magnetic stability is best assured by subjecting it to small cycles of demagnetizing and remagnetizing force about the point of magnetization at which its magnetism is thereafter to remain constant. It would, indeed, be advantageous to repeat this small cycle several times over, so as to bring the magnetic state into a final condition, where the effects of any accidental external magnetic influences will be a minimum.

*Extracted from "The Magnetism of Permanent Magnets," by Silvanus P. Thompson. Reprint from *Journal of Institution of Electrical Engineers*, 1913, Part 217, Vol. 50, pp. 80–142.

[1] Mr. George Hookham kindly informs me that for meter magnets the firm of Chamberlain and Hookham do not resort to partial demagnetization. "We flash our magnets," he says, "to saturation, and never think of reducing them, and find them sensibly permanent—that is, if they have only the air-space to deal with. If they have other reversing influences to contend with, as in alternating-current meters, then we may reduce them."

A Cataleptic Insect

Prof. Schmidt, of the Imperial University of St. Petersburg, now demonstrates, after a long and patient observation, that an insect, the *carausuis morosus*, has the surprising property of placing itself in a perfect state of catalepsy. The insect is found in the north of India and in Afghanistan, but can also be raised in European laboratories. As in other insects of the same family, it imitates twigs and branches, and has a long form so that its appearance closely resembles a tree twig. It is a nocturnal insect and is only active after the sun sets, being quite motionless during the day, having a green color, and is thus hardly to be distinguished from the parts of the tree on which it remains. It was supposed that the insect was in a state of sleep or of simple inactivity or repose, but Prof. Schmidt now proves that it is really in a state of catalepsy, for the muscles can now be handled just as wax and made to take any position, such as is found in the case of higher animals when in this state. An insect will remain standing on its head for four or five hours, and others were bridged across between two books and loaded with pieces of paper whose weight would have crushed the living insect. He also made them take a position noticed in hysteria or epilepsy, with the body bent in circle and resting only on the head and rear end, and such positions were kept for hours at a time and without the least sign of life. To bring the insect back to the normal state, it is required to give them a prolonged excitation of the nervous system, such as by pinching the end of the abdomen or using an induction coil. He can only explain the state of catalepsy by a natural faculty of producing this condition at will.

The largest British steamship—the White Star liner "Britannic."

The Transatlantic Steam

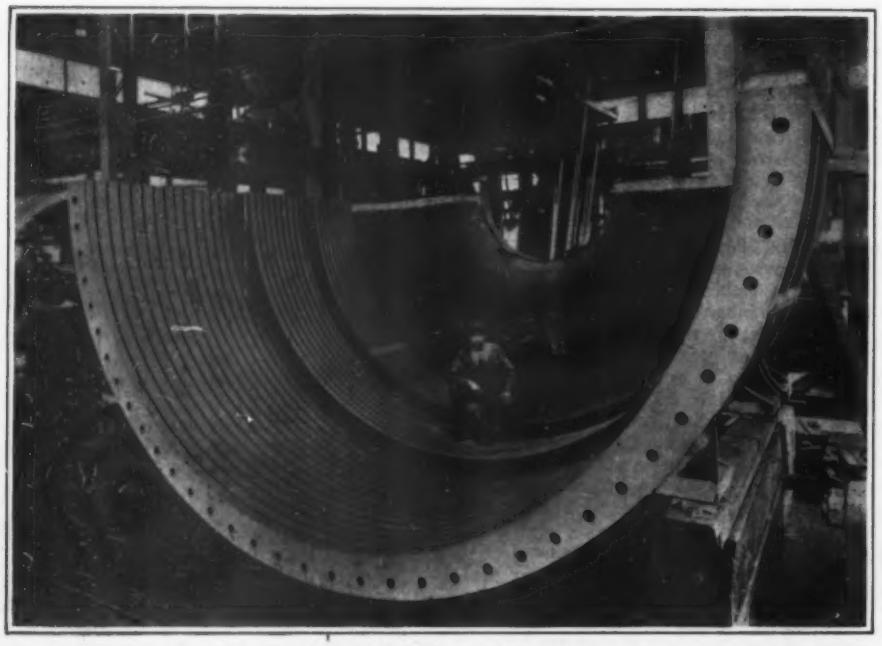
A Fifty-Thou[sand]-To[n]

Unprecedented activity has marked the progress of th[e] last two or three years. No less than four great steamshi[ps] been launched or put in service during this period, the "[Ma]tania," and, quite recently, the "Britannic." One has alm[ost] great transatlantic fleet as an annual event. The [fa]st be[lief] century and the ships that established connection [be]tween last century is only one of the many marks of that [ge]neral a[d]vance is so characteristic of our age. But luxurious travel[l]ing, h[ow]ever requisite. "Safety first" is the slogan of the day, [to] which lent within recent memory by the greatest disaster [in] the safety first has been heeded as far as is humanly possible in depicted on this page, the "Britannic" of the White Star Li[ne] of this year. A highly developed system of divisions into skin affords the best protection against accident obtainable far caution has been carried will be understood from the fac even if six compartments are flooded.

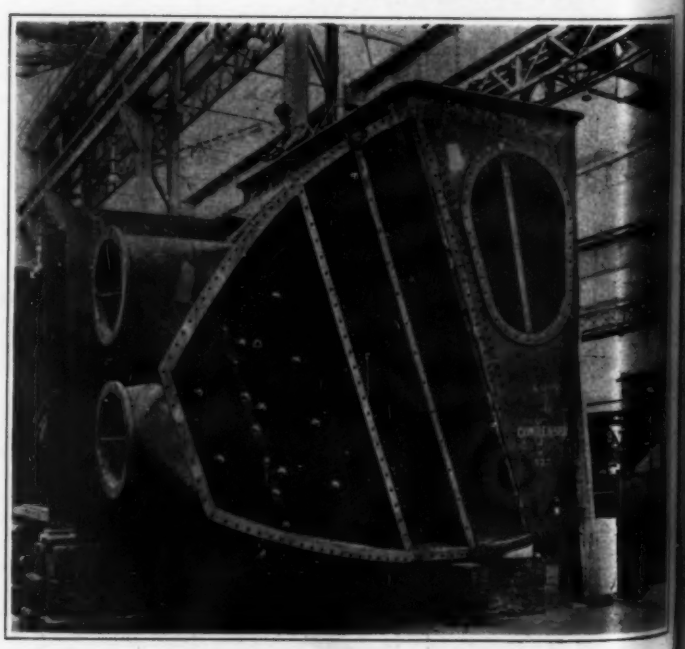
We shall await with interest the arrival, in due time, o

View of double skin construction.

View of turbine rotor in lathe, partly bladed.



The inside of the turbine casing.



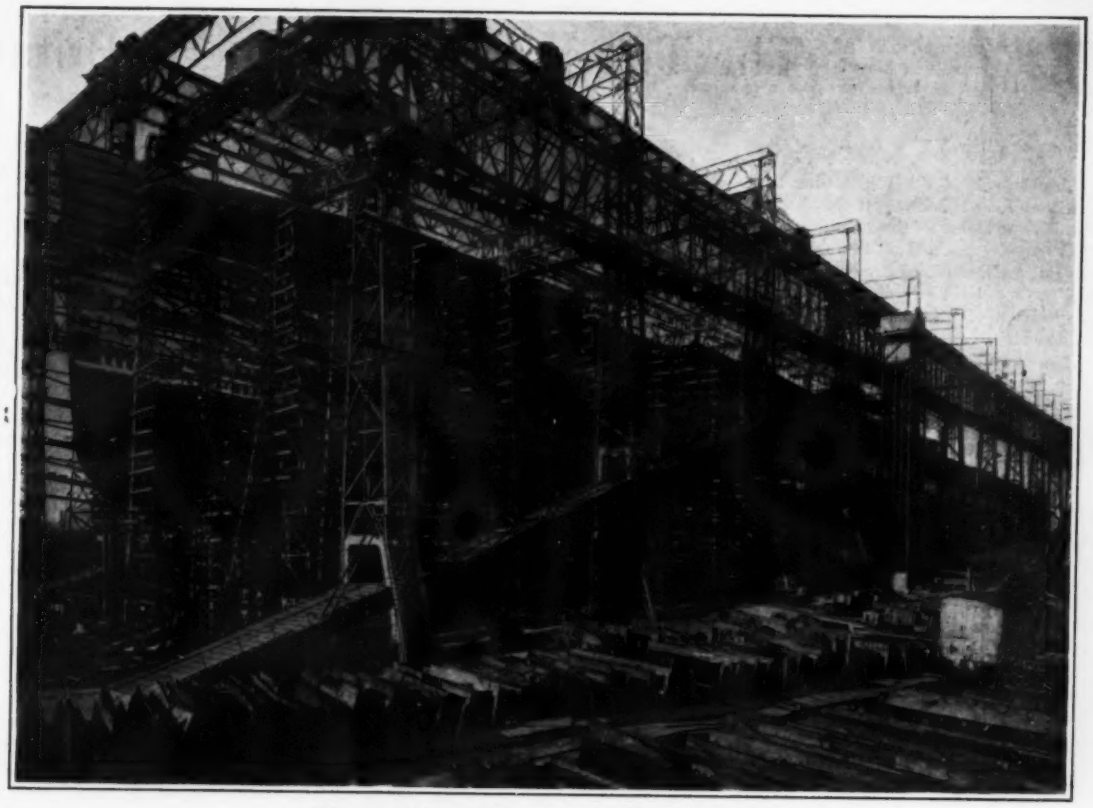
The huge condenser.

lantic Steamer "Britannic"

Fifty-Thousand-Ton Craft

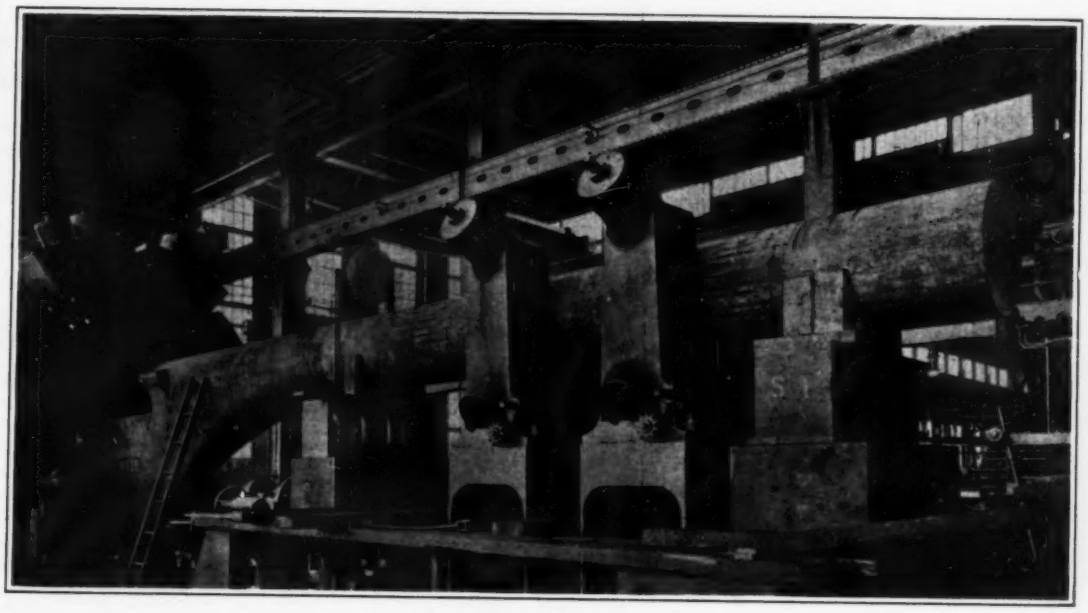
rked the progress of the transatlantic shipping world within the
n four great steamships of some 50,000 tons displacement have
ng this period the "Imperator," the "Vaterland," the "Aqui-
annic." One has almost come to expect such additions to the
vent. The contrast between these floating hotels of the twentieth
ed connection between the two continents about the middle of
narks of that general advance in our industrial civilization which
luxurious travelling, however much appreciated, is not the first
n of the day, to which a somewhat sinister emphasis has been
reatest disaster in the history of navigation. And the cry for
is humanly possible in the construction of the modern leviathan
' of the White Star Line, launched on the 26th day of February
stem of division into bulkheads and the provision of a double
t accident obtainable by modern shipbuilders' technique. How
nderstood from the fact that the "Britannic" will be kept afloat

arrival, in due time, of the new ship in our harbor.

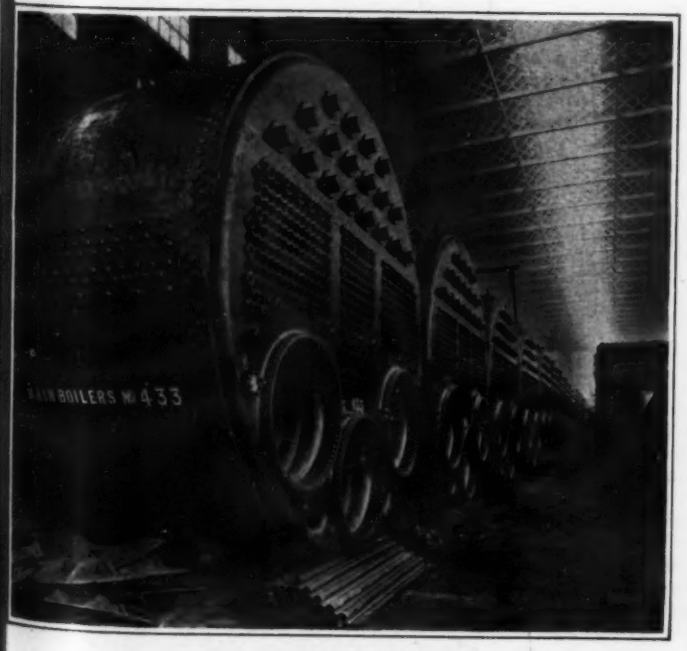


The great hull enveloped in a forest of false work.

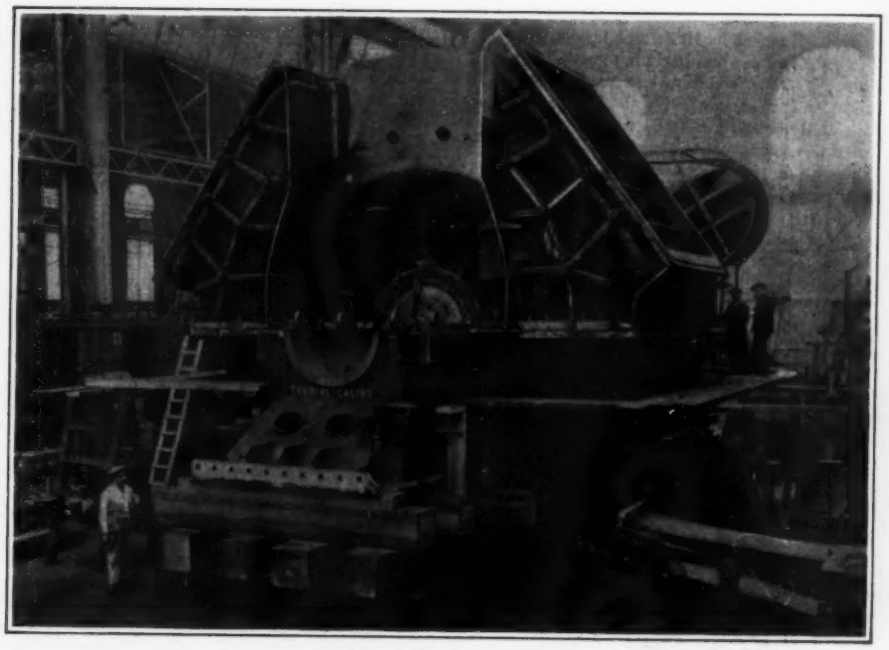
One of the connecting rods.



The rudder head in the lathe.



Some of the boilers in the shop.



Exterior of the turbine casing.

The Transatlantic Steamer "Britannic"

A New Giant of the Seas

THE launch of the White Star triple-screw steamer "Britannic," at Belfast, on the 26th of February, 1914, furnishes evidence of the wonderful progress and success that may be attained by the maintenance of high commercial and industrial standards. In the new "Britannic" we see, both in design and construction, as perfect a specimen of man's creative power as it is possible to conceive.

The new vessel is about 900 feet long and 50,000 tons gross register; and in general features will be similar to the "Olympic," with various improvements introduced as the result of the experience gained in that vessel. Both in design and workmanship the element of strength has been kept steadily in view, and the most approved structural arrangements suggested by the latest experience have been adopted. The double bottom extending the whole length of the vessel, the massive beams and close framing, the large shell plates, the steel decks, the double skin and water-tight bulkheads, combine to make a structure of exceptional strength and rigidity. The hydraulic riveting in the vessel is also an important factor, the whole of the shell plating up to the turn of the bilge being riveted by hydraulic power, and an immense amount of this riveting having also been carried out in other parts of the vessel—shell, top sides, decks, stringers, etc. The rivets were closed by means of the powerful 7-ton riveting machines suspended from the traveling frames on the gantry.

The inner skin consists of heavy plating, well stiffened, extending for more than half the length of the vessel, from the watertight bulkhead in front of the forward boiler-room to the after end of the turbine engine-room, and being strongly connected by longitudinal plates and angles and specially strong connections at bulkheads and watertight divisions. This reinforced structure also extends from the tank top—i. e., from the top of the double bottom—to above the middle or "F" deck, and the watertight bulkheads are carried right up to the bridge deck. The strength and safety afforded by this method of construction will be easily appreciated when it is mentioned that the "Britannic," like the "Olympic," in which the inner skin and similar watertight divisions were introduced, besides having this extra protection against serious damage, will be able to float with any six compartments flooded.

The passenger accommodation in the "Britannic" will be generally of a similar character to that of the "Olympic," and naturally, the "Britannic," being a larger ship, still greater facilities for the passengers are provided, such as additional private baths, etc. There will be accommodation for over 2,500 passengers in all, besides a crew of 950. As some indication of the extent of the accommodation in this vessel, it may be remarked that there will be over 2,000 sidelights and windows in the ship. Full advantage is being taken of the enormous size and spaciousness of the vessel in the arrangement of both public rooms and private cabins; and the entrances, the magnificent staircases, promenades and other features will leave nothing to be desired.

No less than seven of the ten decks in the ship are devoted to the passengers—viz., the promenade, bridge, shelter, saloon, upper, middle and lower decks, which are named alphabetically A, B, C, D, E, F and G; and, while the first-class passengers will be luxuriously accommodated, the second-class will be also very generously provided for, and the third-class accommodation will be exceptionally good.

Special suite-rooms and an unusually large number of private baths will be distinguishing features of the first-class stateroom accommodations. The second-class staterooms are large and comfortably furnished, and the third-class passengers will have a large number of inclosed berths, including two-berth rooms.

Three electric elevators will be arranged in the main companionway and one at the after end of the accommodation for first-class passengers, also one in the main second-class companionway for second-class passengers. The first-class elevators in the main stairway will serve six decks, and the second-class extend through seven decks.

The first-class promenades on the three top decks are such as could be provided only on a vessel of this size. The promenade deck is over 400 feet long, very wide and inclosed for half its length on each side of the vessel, having a solid side screen with large square windows which can be raised or lowered at will so that passengers can enjoy the conditions they prefer, having protection from the weather, and at the same time a clear view of the horizon. The promenade on bridge deck forward is 132 feet long, very wide and inclosed for the whole of its length. There is also fine promenade space on the boat deck. The promenades in the other classes are also well situated and spacious.

An important feature will be the arrangements for handling the boats. The vessel is fitted with the latest and most approved type of electrically-driven boat-lowering gear, by means of which a very large number of boats can, one after the other, be put over the side of the vessel and lowered to the water-line in much less time than was possible under the old system of davits. One of the advantages of the new system is that the passengers take their places in the boats expeditiously and with perfect safety before the boats are lifted from the deck of the vessel, and the gear is so constructed that the fully-laden boats are lowered at a very considerable distance from the side of the ship, thus minimizing risk in bad weather. Moreover, the whole of the boats on board can be lowered on either side of the vessel, whichever happens to be clear, and the gear has been kept so far inboard as to give a wide passage at either side of the ship for promenading and for marshaling the passengers expeditiously in case of a sudden emergency.

The "Britannic" is a triple-screw steamer, having a combination of reciprocating engines with a low-pressure turbine, by which two main objects are attained—the greatest comfort insured to passengers by the smooth working of the ship, and, from an engineering standpoint, the utmost economy in the utilization of the energy of the steam.

A Museum of Evolution

The Founding of a Repository Favorable to Everybody

By Dr. Alfred Gradenwitz

THE doctrine of evolution, as founded by Darwin and further developed by Haeckel and others, after the violent opposition it had found in the beginning, may be said now to be universally accepted. In fact, no modern exposition of zoology or botany purporting to be really up-to-date, can be based on other but evolutionary principles. Though the spirit of evolution pervaded the teaching of biology, there was no museum illustrating in an adequate manner this doctrine. The idea of founding such a repository accessible to everybody first occurred to Haeckel in 1904, and he contributed toward its foundation the honorarium received for his "World Riddles." Other contributions were collected from his friends, and when the University of Jena celebrated its 350th anniversary, Haeckel was able already to present it with the museum building. However, on account of old age, he had to resign his duties as university professor and at the same time as director of the zoological institute to which the museum is attached. His successor, Prof. Plate, faithfully continued the work of the master and made it his task speedily to complete the museum collections.

The Haeckel Museum of Evolution which was inaugurated at the end of May, is intended, not to embrace as many species as possible, but to give a vivid picture of evolution in its effects on the various representatives of the animal kingdom. In order to emphasize the continuity of the latter, man himself has been given his proper place among his fellow creatures.

The variability of species has been illustrated in a striking manner. On first entering the museum we note, perched on a twig, the *Gallus bankiva*, the wild fowl still living in India, from which all domestic races are derived, and *Columba livia*, the wild pigeon which still lives on the coasts of Norway, and of Dalmatia as well as other rocky seaboards, and which represents the first stage in the evolution of the pigeon races. Distributed in pleasing groups, we then see fowls and pigeons of all sizes and of the most varied forms, illustrating the whole pedigree. The inscription on a plate fixed to this as well as to other cabinets, imparts to visitors any further information they may desire, emphasizing the fact that variation, so far from being limited to some organs, really extends to all of them. A neighboring cabinet contains a comprehensive collection of the biggest anthropoid apes.

On entering the right hand hall we see a striking demonstration of the fact that species is a notion arbitrarily created by man and which has nothing definite or of intrinsic value about it. The first cabinet, which is full of birds and of butterflies, illustrates the thorough difference between males and females, and if there was no written notice, nobody would suspect both to be representatives of the same species, the more so, as there are frequently even considerable differences between females. Extensive series of the same kind, however, show how the appearance of females more and more approaches that of the male representatives of the species. In the present state of the science it is generally supposed that males are leading and females slowly following in this evolution. The same far-going differences and variety of form are shown in the adjoining cabinet on coleopters.

Another cabinet illustrates by some striking examples the principle of variability on which the whole doctrine of evolution is based. Moles of the most different sizes and colors as well as hedgehogs, hamsters and foxes are seen, one of the last being bluish-gray, another red and one white, though they all were shot in Germany. These facts are brought home to us even more forcibly by the next cabinet, with its butterflies, of which samples of the same species are on show in all gradations from white to black, and its collections of snails and mussels. The cabinet of geographic variation shows—most instructively distributed over a map from Madeira as far as Asia Minor—quite different looking specimens of *Helix pomatia*, the common snail, and a strange lengthy snail (*Cerion glans*). This is found on a Bahama Island, and whereas the specimens coming from the west coast show striking stripes, these become ever fewer in number toward the interior of the island until the shell of snails from the east coast is quite smooth.

What, however, is even more remarkable than the variability of species, is that not even the notion of *genus* can be strictly defined. This is shown, for instance, on American butterflies, which are much like the continental brimstone butterfly. While being thoroughly different at the ends of the series on show, these gradually approach one another so closely that, in spite of their belonging to different genera, no ordinary skill is required to distinguish between those in the center of each row. The same fact is illustrated on birds, while another instance of variability is found in a large collection of eggs of the guillemot living on Heligoland, which comprises slightly speckled white samples and others passing through the whole series of hues to strongly speckled dark-green specimens.

We further see samples of organs developed to enormous size, and, on the other hand, of rudimentary ones stunted in their growth, which no longer properly serve their purpose. On one hand, beetles with surprisingly long tentacles, spiders with enormous legs, the horn-hog of Celebes with tusks reaching up to the forehead, and on the other hand, the pelican with its long, broad bill and a tongue hardly reaching the size of a pin, or skulls of predatory animals which only feed on insects and the teeth of which hardly show any feature of the beast of prey. Again, we note some striking examples of animal polymorphism, viz the various forms occurring within the same tribe, e. g., in the case of bees, the queen, working bees and drones, and in the fauna of Australia, the peculiarities of a region entirely separated from the remaining world since the mesozoan. Interesting instances are further shown of heredity in man, pedigrees of families with missing fingers, affected with albinism, or characterized by a single white curl of hair always occurring at the same place, or by the same morbid swelling of the legs. On the cobs of Indian corn are further demonstrated the stunting action of inbreeding and the invigorating effects of crossbreeding. A collection of colored and white mouse skins then shows that in a row of generations the proportion between the light and the dark skinned offspring has been just

the same as calculated according to the Mendelian law. However, we also see that in the representatives of a given generation there are dormant remains of characteristics belonging to earlier generations, that, for instance, many women, especially in their old age, show traces of a beard and that different animal species often tend to become more and more alike. Mongrels of butterflies with the left wing characteristic of the appearance of males and the right wing showing the female type, are extremely peculiar.

The adjacent hall contains the next of kin of man. Opposite to the entrance there is a mighty gorilla, 1.71 meters (5.61 feet) in height, followed by many specimens of all other anthropoid apes. Very instructive is a comparative collection of their skeletons and those of men; a series of skulls of monkeys, of Pithekanthropus, of Australasians, of Europeans and that of the Neanderthal man; the tibias of the gorilla, the man of Spy, the mousterian and the present-day man as well as the famous lower jaw found at Heidelberg, with teeth quite human and jawbones absolutely ape-like. On the upper story are exhibited some instances of ontology, e. g., the evolution of a chicken, some young flounders still symmetrical on both sides, as well as a young lion and a young puma, both showing all the characteristics of cats. We also note some interesting instances of mimicry, flies which are closely associated with bees and which have the same appearance as these, butterflies looking like the hornets among which they live, and others whose wings bear on the upper side a variegated picture, but when folded back look like the very leaves of the shrub they are sitting on. We enter then the paleontological department, comprising the saurians of slate, snails of a large number of rocky strata of western Slavonia, corals and deep-sea fishes.

Though not being extensive in itself, this museum contains ample material for many hours of inspection. Those taking the trouble of thoroughly visiting all its departments will seize the true significance of the doctrine of evolution. Some of its halls are not yet completed, e. g., the aquaria room and especially the garret story, which is to become the first German institution devoted to experimental research on heredity.

In concluding, the writer wishes to thank Profs. Lennhoff and Plate for courtesies extended to him in preparing this article, and to acknowledge his debt to the *Vossische Zeitung* that originally published matter from which the above information was partly derived.

The Production of Radium

SOME NEW PROCESSES OF EXTRACTION.

WERE the production of radium dependent entirely upon the supplies of pitchblende available, the outlook for the future would be very poor indeed. Pitchblende sometimes contains as much as 60 per cent of uranium, and radium always occurs with uranium in the proportion of about one part in three million. The richest pitchblende has been mined at St. Joachimstal, in Bohemia, but further supplies are being conserved by the Austrian Government. A very fair percentage of uranium is also associated with thorium in some examples of thorianite. It may be mentioned that one result of the shortage of rich uranium minerals has been the development of the use of mesothorium, which may be regarded as a by-product of the incandescent gas-mantle industry. But whereas the average life of radium is 2,500 years, that of mesothorium is only about eight years; and thus, while money spent on radium may be taken as being unaffected by depreciation, a store of mesothorium would need replenishment in a few years.

There are, however, large supplies of minerals containing some 1 or 2 per cent of uranium. Among such "low-grade" minerals autunite and carnotite perhaps come next to pitchblende and the uraninites in respect of uranium content. Orangite and other minerals also contain uranium, and the supply of radioactive material would be fairly wide if all these minerals could be included from the point of view of radium production.

ORDINARY METHODS.

The usual processes of radium extraction are, however, tedious and protracted, and the difficulties of economically treating the poorer minerals by their aid are very great. The operations begin with the removal of the uranium, or of the uranium and vanadium in the case of carnotite. The residues contain a great deal of silica, and a large number of metals that are ordinarily present have to be got rid of. The radium is obtained usually in the form of a mixture of radium and barium chloride at the end of the first or "opening-up" process, and the final operation consists in separating the pure radium chloride from the barium salt, a process which may take several months.

The first operation is generally effected by boiling the residues with sodium carbonate solution, when the radium and barium form insoluble carbonates. These are dissolved in hydrochloric acid, certain chlorides of other metals also remaining in the solution. The radium-barium is next precipitated as sulphate, which is once more converted into carbonate, and this again into chloride. Finally, the material is submitted to a long series of fractional crystallizations, by which radium chloride is gradually separated out in a more or less pure state.

When it is remembered that these minerals, except pitchblende, often contain as little as one grain of radium to six or seven tons of mineral, the extraordinary difficulty of extracting the radium is at once evident. One hundred tons of mineral may yield a gramme of radium, and to treat this amount of ore or of residues correspondingly large quantities of reagents must necessarily be employed. The high price of radium is explicable by these circumstances, especially in view of the delicacy and skill with which the various operations must be carried out.

RECENT ADVANCES.

One of the most important advances in the technique of radium extraction that has so far been made is perhaps a concentrating process which has been invented by two English chemists, Messrs. Kent Smith and H. B. Rolfe, whereby the radium-containing residues can be reduced in bulk so that about 95 per cent of the material is discarded. A similar result, but to a much smaller extent, has also been attained by the Denver Bureau of Mines, U. S. A. By the former process a ton of residues can be so treated that within a few hours the great bulk of the radium is retained within a mass of about one hundredweight, and this smaller bulk can be worked at little more than one twentieth of the cost otherwise involved. It is thus possible to deal with ores containing such small percentages of radium that its extraction by the ordinary processes would be prohibitive in cost.

Prof. Sommer, of Vienna, has during the past few months been extracting radium, in the form of radium-barium chloride, by a new process which takes only a very few days; while Prof. Ebler, another distinguished Austrian chemist, has devised a speedy process of final extraction to do away with the fractional crystallization. —*Engineering Supplement, London Times.*

The Napier Tercentenary

IT is proposed to celebrate, by a congress to be held in Edinburgh on Friday, July 24th, and following days, a great event in the history of mathematics—the publication in 1614 of John Napier's "Logarithmorum Canonis Mirifici Descriptio."

Known to fame as the inventor of logarithms, Napier was a man of wide intellectual interests; but it was to mathematics that he devoted chiefly his leisure through life. Apparently his earliest investigations were directed to systematizing the sciences of algebra and arithmetic. He conceived the general principles of logarithms in the course of 1594, and he devoted the next twenty years to developing the theory of them, in perfecting the method of their construction, and in computing the canon or table itself. While thus engaged he invented the present notation of decimal fractions.

The "Descriptio" embodied the triumphant termination of Napier's labors, and contained, in addition to the canon or table, an explanation of the nature of logarithms, and of their use in numeration and in trigonometry. It was dedicated to Prince Charles, afterward Charles I. The original edition was reprinted at Lyons in 1620 and in London in 1807.

Napier's last work, "Rabdologiæ Seu Numerationis Per Virgulas Libri Duo," was probably begun in 1615. He explained the title "Rabdologiæ" as "numeration by little rods." These rods, being usually made of bone or ivory, were familiarly called "Napier's bones." In an appendix, "De Expeditissimo Multiplicationis Promptuario," he described another invention for the performance of multiplication and division—"the most expeditious of all"—by means of metal plates arranged in a box. This is the earliest known attempt at the invention of a calculating machine.

The coming celebration is being held under the auspices of the Royal Society of Edinburgh, on whose invitation a general committee has been formed, representing the Royal Society of London, the Royal Astronomical Society, the Town Council of Edinburgh, the Faculty of Actuaries, the Royal Philosophical Society of Glasgow, the universities of St. Andrews, Glasgow, Aberdeen and Edinburgh, the University College of Dundee and many other bodies and institutions of educational importance.

The proceedings will be opened on Friday with an inaugural address by Lord Moulton, followed by a reception given by the Lord Provost, magistrates and council of the city of Edinburgh. On Saturday and Monday the historical and present practice of computation and other developments closely connected with Napier's discoveries and inventions will be discussed. A memorial service will be held in St. Giles's Cathedral on Sunday.

Among many who have expressed a warm interest in the celebration, and who hope to take part in the congress, may be mentioned Prof. Andoyer, Paris; Prof. J. Bauschinger, Strassburg; Prof. Hume Brown, Historiographer Royal for Scotland; Prof. F. Cajori, Colorado, U. S.A.; Prof. G. A. Gibson, Glasgow; Dr. J. W. L. Glaisher, Cambridge; Prof. Lang, St. Andrews; Prof. Macdonald, Aberdeen; Prof. E. Pascal, Naples; Prof. Karl Pearson, London; Prof. Eugene Smith, New York; Prof. Steggall, Dundee; Prof. Whittaker, Edinburgh.

Merchiston Castle, the residence of Napier, has long been occupied by the well-known public school, which draws pupils from all parts of the British Empire. The governors of the school have kindly invited the members of the congress to visit the castle and grounds on Saturday afternoon.

Relics of Napier, collected by Lord Napier and Ettrick and other representatives of the family, will also be on view; and it is intended to bring together for exhibition books of tables and forms of calculating machines which may reasonably be regarded as natural developments of the great advance made by Napier.

Individuals, societies, universities, public libraries, etc., may become founder members on payment of a minimum subscription of $10, and each founder member will receive a copy of the memorial volume, which will contain addresses and papers read before the congress, and other material of historic and scientific value. Ordinary subscribers attending the celebration may receive copies of the memorial volume at a reduced price.

All who are interested in the celebration are invited to communicate with the general secretary of the Royal Society of Edinburgh, 22 George Street, Edinburgh.

Voting Taught by Motion Pictures.—A novel use of the cinematograph is reported by the American consul at Catania, Italy. A new suffrage law in Italy has increased the number of electors from 4,000,000 to 8,000,000 or 9,000,000, and the task of teaching the new voters, many of whom are illiterate, to cast their ballots properly is a heavy one. Throughout the district of Catania the moving-picture theaters have been exhibiting films showing the procedure to be followed at the elections. The consul states that, in view of the success attained by this method of educating the public, physicians and others are planning to employ a similar method of teaching domestic and personal hygiene and similar subjects.

Some Experiments With Different Systems of Lateral Control*

MR. W. E. SOMERVILLE, of Coal City, Illinois, U.S.A., sends us the following interesting account of some experiments with different systems of lateral control which he has carried out during the years 1910–1913, in order to determine the best form of *ailerons:*

"Machines Nos. 1, 2 and 3, as shown in the accompanying photographs, all had shutters, which were not interconnected, and which were operated by opening the shutters on the higher wing, thereby partly reducing the area and the lift, while the added resistance caused a drag, which retarded the speed of the higher wing tip.

"System No. 1 was found to be inefficient when the machine was near the ground, and so was discarded in favor of No. 2. This was quite good, and the machine would right itself almost immediately, while this form of *ailerons* also proved to be quite good as a rudder, in fact, while the experiments were being carried out the rudder was very seldom used. However, as the shutters were kept closed by means of a heavy spring the action of opening them against the pull of the spring entailed some rather hard work, so this system was discarded.

"System No. 3 was fairly good, but not so effective as No. 2. It was used, however, on the 1912 machines by the aviators E. Korn and E. S. Daugherty. On my 1913 biplane a new design (No. 4) was tried. This system is practically the same as the Farman, but operates exactly the opposite way.

"In order to correct a bank the *aileron* on the higher side is raised, thus causing a downward pressure as well as a drag on the higher wing. This, of course, accelerates the speed of the lower wing, and consequently increases the lift so that the machine rights itself without the use of the rudder. Then another system was tried in which the *ailerons* were interconnected, as in the modern Farman and Curtiss machines, but with the exception that when in their normal position the *ailerons* presented a negative angle of incidence to the line of flight. The *ailerons* were so adjusted that when the controls

* Reprinted from *Flight.*

were moved to their full limit the *aileron* on the lower wing was in line with the trailing edge, while that on the higher wing presented the necessary resistance and downward pressure to right the machine. I consider this system the best because it is easy to operate, and produces practically no resistance on the lower side. It also appears to add considerably to the general stability of the machine. My object in testing so many systems was to produce a design which would be effective, efficient and safe, without causing any drag on the lower wing, and one which would at the same time work indedendently of the rudder. Nos. 2 and 4 are particularly suitable, since either *ailerons* or rudder may be used for both purposes.

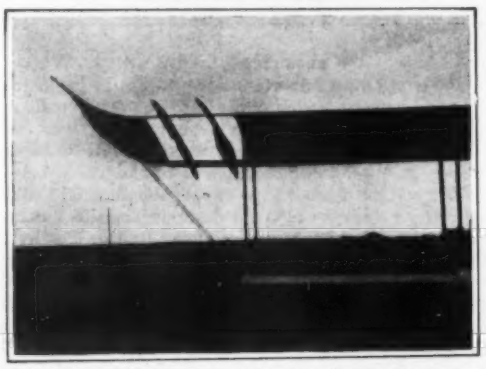
"Although my machine has been flown repeatedly by M. Daugherty without *ailerons* and with only the rudder to maintain lateral stability, it is my opinion that *ailerons* are necessary if only to make one feel secure. The upturned wing-tips assist greatly in giving one this confidence, as it prevents that sideslip which has proved fatal to many an aviator. Not only that, but they practically maintain lateral stability. This may seem a very strong claim, but it is a fact which has been proved on numerous occasions.

"I engaged a supposed aviator to fly my machine (later he informed me that he had never been in an aeroplane before). However, the 80 horse-power H. Scott was started, and away he went, climbing at a terrible angle. It was evident from the start that he knew nothing whatever about flying. When he had reached an altitude of about 250 feet he did a banked turn, climbing all the while, and in this critical position he stopped the engine! The machine, of course, lost all headway, and began to drop vertically. Gradually the lower wing and the tail rose to a level, and the machine commenced to glide forward and landed heavily, smashing two wheels and the skids, but suffering no further damage. The 'pilot' escaped without a scratch, but was half dead from fright!

"The upturned wing-tips have saved my life on more than one occasion, for in my early experiments my machine was under powered and very unreliable. I unfortunately, one day in June, 1910, gave a private exhibition to my family and a few friends in order to demonstrate my ability as an aviator. Well, the flight terminated with half of the machine in some trees, and the other half, with myself, piled on the ground. The engine being in front I was not much hurt, but the same cannot be said about my feelings, seeing that my family and friends had witnessed the performance. This finished my ambition to become a great aviator, and later, when I have occasionally tried my machines I have always taken good care to do so when my friends were not in sight."

The Somerville biplane. Type 2 aileron used in 1910 experimental biplane.

The Somerville biplane. Type 3 aileron used on 1912 biplane.



The Somerville biplane. Type 1 aileron fitted on 1910 experimental biplane and also used in 1911.

The Somerville biplane. Type 4 ailerons on 1913 machine.

A Volcano in Being

The Eruption of Sakurajima

FROM end to end of the Japanese Empire runs a chain of volcanoes, 17 of which are classed as "active," though several times this number is more or less subject to suspicion. Some geologists credit this small country with 54 active or "recently extinct" volcanoes; and long dormancy, far from being a reassuring token, means rather that if the slumbering Typhœus ever awakes, his awakening will be terrible. Bandaisan, whose eruption in 1888 was the most stupendous that Japan has ever experienced, had been silent for a thousand years previous to that time.

Near the southern extremity of Kiusiu, the southernmost large island of Japan, a volcanic isle, of typical conic form, lies off the harbor of Kagoshima. Its name, Sakurajima, or Sakurashima ("Cherry Island"), suggests a smiling landscape such as was presented, until a few weeks ago, by the verdant and highly cultivated slopes of the mountain. Sakurajima is supposed to have risen from the sea in the year 718 A. D., and had been the scene of seven eruptions previous to the present year. A violent and destructive one occurred in 1779, in commemoration of which a monthly festival has ever since been observed, on which no boats are allowed to leave the island. A minor outbreak occurred in 1860. This island supported a population of some 25,000 people, who took pride in raising oranges and 70-pound radishes (*daikon*). It was a favorite rendezvous of travelers, drawn thither by the hot baths of Arimura and the superb view from the mountain summit. Of the two craters which crowned the mountain, only one showed signs of ultimate activity in the shape of occasional clouds of steam.

Sakurajima is one of four volcanic vents in the island of Kiusiu, all of which probably open into the same magmatic reservoir. One of these, Kirishima, 25 miles north of Sakurajima, was in violent eruption in 1895, and has never been entirely quiet since. Paroxysmal outbreaks occurred here in November and December of last year, and a more persistent eruption began on January 8. Japanese vulcanologists had accordingly felt serious misgivings regarding the behavior of the other vents of the group. On January 10th the premonitory signals which, by a merciful dispensation of Providence, are rarely lacking before a volcanic outburst, caused the more cautious inhabitants of Sakurajima to begin preparations for flight. On the afternoon of Sunday, the 11th, earthquake shocks and subterranean rumblings accelerated the exodus. At this stage of events, it is related that an ultra-crepidating meteorologist of very minor fame—viz., the officer in charge of the weather station at Kagoshima—urged the islanders to remain at home, on the ground that, theoretically, the volcano was not going to "erupt." Although his advice was not heeded, and the populace chose practical, in preference to theoretical, safety, the chagrined official is said to have committed hara-kiri as soon as he recognized his blunder.

On the morning of the 12th, the volcano was unmistakably in eruption. Fortunately the island was now almost completely deserted, but serious danger threatened the populous city of Kagoshima, only 8 miles from the active crater. Within a period of 30 hours, no less than 345 shocks of earthquake were felt in that city, and several buildings crumbled. A hail-like shower of lapilli and dust set in, ultimately accumulating to a depth of from 2 to 15 feet in Kagoshima. Telegraph, telephone and electric light wires were prostrated, adding to the panic and confusion. The population hastily decamped. Special trains were run out of the city to carry the refugees, but railway travel was soon interrupted by the heaps of pumice on the tracks. On Tuesday afternoon, still further damage and dismay were caused by invading "tidal" waves.

Throughout the week, the volcano continued to belch forth steam, rocks and ashes, with occasional moderate explosions and alternating periods of subsidence. At the same time the eruption of Kirishima remained unabated; and, in fact, it appears to have reached greater violence than that of Sakurajima. The other two volcanoes of Kiusiu, one of which, Aso-san, is the largest crater in the world, rumbled and smoked ominously, but did not reach a stage of actual eruption. An intense renewal of activity occurred in Sakurajima on Saturday, the 17th, after which the real eruption was over, though detonations and seismic shocks continued for several days after. Meanwhile a haze of volcanic dust spread over most of Japan. Copious showers of ashes fell at Nagasaki, nearly 100 miles from the scene of the eruption.

The Japanese government took prompt measures to mitigate the effects of the disaster. A squadron of warships was dispatched to Kagoshima, carrying surgeons and nurses. Both the navy and the army aided actively in the work of rescue. The Emperor sent one of his court officials to examine conditions and organize relief. Contrary to expectations, a few living people were found by rescuers on the island itself several days after the eruption began. One group of 33 persons was discovered on Wednesday afternoon huddled under protecting rocks at a point only half a mile from the crater.

Prof. Omori, Japan's greatest seismologist, hastened to the scene from Tokyo. The Japanese people have implicit faith in Omori, whose researches have done so much to rob the ever-recurring earthquake of its terrors, and accordingly a reassuring bulletin which he issued on the 16th brought about a general return of the people of Kagoshima to their homes. In this bulletin, he stated that even in the most violent eruptions known in Japan, the fall of lava blocks weighing as much as 19 pounds has been limited to a zone of about 3¾ miles radius from the crater, hence Kagoshima was entirely safe from this danger; that all the earthquake shocks attending the eruption were of purely volcanic origin, and would not become strong enough to destroy the remaining buildings; and that not enough gas from the crater could reach the city to produce poisoning or suffocation. At the same time he urged the necessity of protecting the city from sea-waves of seismic origin.

Early accounts of the eruption of Sakurajima were greatly exaggerated. Neither in the violence of the outbreak nor in the amount of devastation was this event of much consequence in the annals of vulcanology. The following semi-official figures from the *Japan Mail* indicate the extent of the damage so far as known:

In Kagoshima, 148 houses were demolished; 524 were badly shaken; 12,090 require thorough repairs; 16 boats were burned; 12 bridges fell; 1,000 fences were destroyed. Deaths, 17; wounded, 75. In the suburbs of Kagoshima, 7 people were killed. Nearly all these accidents were the result of the earthquakes, and not directly of the eruption.

On the island of Sakurajima, the following villages were completely destroyed: Akami, Yokayama, Koike, Akagibara, Seto and Waki. At Take, about half the houses were destroyed; at Fujino and Nishimichi, only a few. None were destroyed in the villages of Furusato and Nojiri. The total property loss on the island is estimated at $1,965,000. There appears to be no trustworthy information as to how many people perished on the island, but the number was probably very small, as the volcano gave ample warning of the impending eruption, and plenty of boats were available. Some people were injured by the stampede of horses and cattle from the scene of the disaster.

A feature of volcanic eruptions which has recently become prominent in scientific literature is the transportation of volcanic dust, by air currents, to regions remote from its place of origin, with possible meteorological effects of importance. After the tremendous eruption of Krakatoa, in 1883, a veil of fine dust spread around the globe, causing diminished sunshine and remarkable twilight glows for two or three years. Similar effects, but of less duration, were observed after the eruption of Katmia, in 1912. In both these cases, the dust was undoubtedly hurled to enormous heights; far above the troposphere, with its storms and strong vertical currents. The dust of Krakatoa is supposed to have reached an altitude of over fifty miles.

Eye-witnesses of the recent Japanese eruption describe the cloud of dust and vapor as rising "several thousand feet" above the crater; but as a rule such estimates are of little value, as the cloud spreads in a pall of darkness over the observer's head, and its summit is invisible.

Curiously enough, observations made on the crest of the Blue Ridge, in Virginia, may prove to be an indication of the height of the dust cloud over Sakurajima, and hence of the violence of the eruption. At Mount Weather Observatory, the sun rose on the morning of January 23d a red ball of fire, in a sky free from ordinary clouds, but overspread with a filmsy haze. This haze, which did not obscure distant objects near the ground, persisted nearly a week, reducing the intensity of solar radiation 60 per cent, and producing a marked effect on the polarization of sky light. It then abruptly disappeared.

It is probable, though not certain, that the haze seen at Mount Weather consisted of dust from Sakurajima, and, if so, its transient character indicates that it was within the storm-stratum of the atmosphere; i. e., not higher than seven or eight miles. This would, then, be the *maximum* limit of the eruption. The actual height may have been much less, as the dust may have been carried upward by air currents.

By courtesy of *Sphere*.

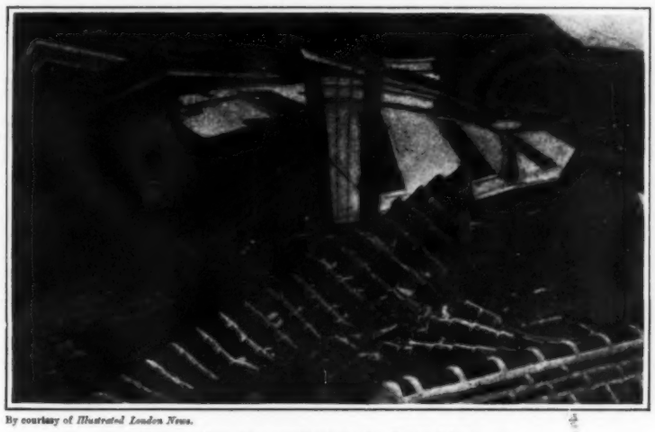
Sakurajima refugees gazing at the wreck of their island home.

By courtesy of *Sphere*.

A great mass of ash-laden steam over Sakurajima.

By courtesy of *Sphere*.

Refugees encamped in bamboo forest near Kagoshima.



By courtesy of *Illustrated London News*.

Scene after the earthquake in Kagoshima.

By courtesy of *Graphic*.

A house crushed by the weight of the ashes.

By courtesy of *Sphere*.

Eruption seen over the earthquake-shaken streets of Kagoshima.

By courtesy of *Sphere*.

Japanese nurses with faces muffled against falling ashes.

By courtesy of *Illustrated London News*.

The disaster to Sakurashima and to Kagoshima, famous for the production of Satsuma ware.

By courtesy of *Sphere*.

View of the shrine of Saigo, which was almost unscathed.

A VOLCANO IN BEING—THE ERUPTION OF SAKURAJIMA

A Study in Aviation Parachutes*

Research in a Neglected Field

By Captain M. Couade

THE number of aviation fatalities to date exceeds 300. France alone has lost 39 military officers, or pilots, and as many civilian pilots. Official inquiry into the military accidents in France prove that 40 per cent of the victims fell more than 100 meters.

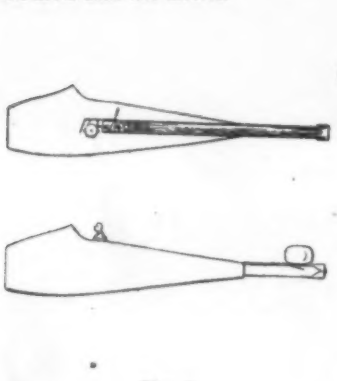


Fig. 1.

Fig. 2.

In order to reduce the number of fatalities, various tentative efforts have been made:

1. Improvement in the structural strength of the wings and the effective operation of the controls;
2. Study of the means for automatic stability of aeroplanes; and
3. Parachutes.

Progress in construction has certainly been fruitful; but still certain breakages of wings, though well constructed, remain inexplicable.

Automatic stability cannot be perfectly attained. The best we can hope for is a measure of security like that of an automobile—a security which depends upon the evenness of the course. But the first two provisions for safety are unavailing in certain accidents which are frequent in war; for example, when a projectile breaks a wing, a rudder or a control.

There remains the parachute as the aeroplane's organ of safety and having no other function. To adapt it to the aeroplane, the following conditions are essential:

1. When resting folded on the machine, it must not affect the flight nor greatly increase the weight;
2. Its unfolding must not be hindered by the aeroplane; and
3. Its unfolding must not entail inertia effects dangerous to the pilot or the suspension system.

The most tempting idea is to attach the parachute to the pilot so as to save him, while abandoning the aeroplane. This scheme, however, presents a capital disadvantage; the operation is risky and the pilot might

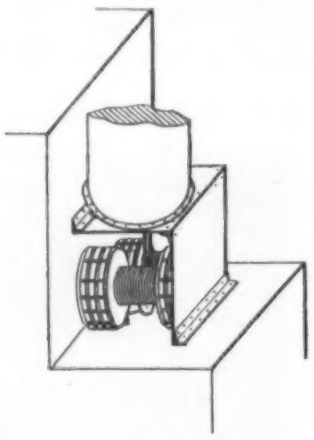


Fig. 6.

hesitate to perform it. It seems, therefore, most simple, certain and practicable to parachute the aeroplane as a whole.

In order to combine these various ideas practically, I have contrived, studied and realized, with the cooperation of MM. Sloan and Verdier, constructors, a parachute system, as shown in Figs. 1 and 2. We construct the parachute of extremely light material; we place it within the body of the machine, the heaviest part under the pilot; folded inside a tube which projects from the rear of the fuselage; we release it top first by aid of a little tractor parachute, normally closed, which at the will of the pilot, opens to the wind and draws forth the large parachute.

In order to obviate a too violent jerk, on the sudden opening of the large parachute, a jerk which might break the suspension cords or excessively jar the pilot, we have interposed between these cords and the aeroplane, a cable passing over a brake, to provide a suitable yielding or elasticity to the system. At a flight speed, for example, of 50 meters per second, a parachute of 7.75 meters radius would have an acceleration of 400 meters per second and a pull on the suspension exceeding 20 tons; where as with a suitable interposed brake the acceleration would be 30 and the pull 3 tons with a yielding of 14 meters. An acceleration of 400 is what a person would have after falling 20 meters and checking his fall within one half a meter; an acceleration of 50 is what a person would have on falling only 2.5 meters with the same checking space of half a meter.

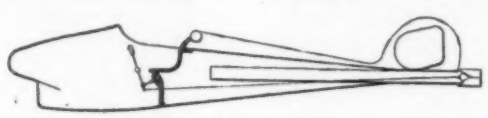


Fig. 3.

What are the practical limits of speed of fall and endurable retardation? As to the first, it is generally estimated that the speed of fall is of the same order as the speed of flight, especially in case of wing rupture. The swiftest racing machines have not exceeded 200 kilometers per hour, or 55 meters per second. We may then take 50 meters per second as the upper limit of the speed of fall. As to the practical limit of retardation permissible, the studies of M. Broca show that the human frame can, without danger, support, in the direction of the spinal column, an acceleration equal to 10 times that of gravity.

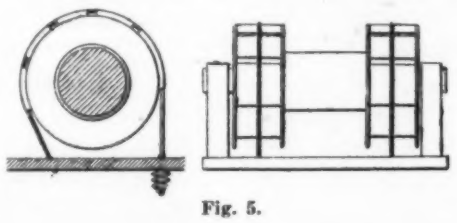


Fig. 5.

On the other hand, it seems unnecessary to strike the ground with an insignificant velocity, if the impact be suitably provided for. If on reaching the ground, the pilot can check his speed through a sufficient space with constant resistance, he will sustain a retardation which, if it does not exceed 100 meter seconds in the direction of his spinal column, need not subject him to any risk. A person who jumps from an elevation of 2.1 meters reaches the ground with the same velocity as our supposed parachute (6.5 meter seconds). It suffices that the yielding space be 0.21 meters in order that the retardation may be 100. But this is an exercise which can be endured by everybody.

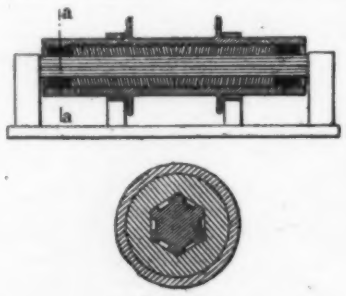


Fig. 7.

The acceleration due to the pull of the parachute on opening is proportionate in value to the speed of unfolding. It seems probable that a large parachute attached directly to an aeroplane would be dangerous, whatever its structural strength or the efficiency of its unfolding mechanism. But with a yielding brake, the acceleration need not exceed 50 meters per second. Also by a device for causing the parachute to unfold gradually, the pull on its cable can be sufficiently reduced. It is, however, necessary to add to the brake mechanism a shock absorber to prevent breakage of the suspension system by reason of its inertia. This absorber may be made of rubber or plastic material, for it need not have much spring.

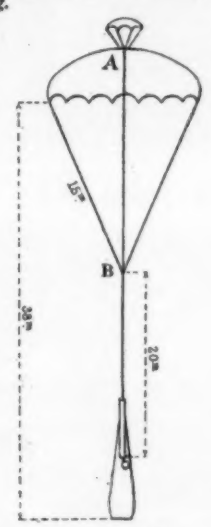


Fig. 4.

Instead of the brake, an elastic cable might be used; but this would be quite heavy, even if made of rubber, and still heavier if made of steel springs. Computation shows that a rubber cable 50 centimeters square in cross-section, and 16 meters long in its state of rest, would serve the purpose and would weigh about 8 kilograms.

The minimum altitude of fall within which the foregoing parachutes would work practically is estimated to be within 100 meters.

Pilot Parachutes.—The foregoing considerations apply also to parachutes for lowering the pilot alone. It is, however, easier with these to avoid the dangerous effects of acceleration by having the parachute to unfold gradually, and by employing an elastic suspension whose weight would not be excessive.

The difficulty of preventing the parachute from striking certain parts of the apparatus, the rudders in particular, is not insuperable. Fig. 3 represents an arrangement which would be able to operate successfully. The seat to which the pilot is attached is held to the aeroplane by a flange arranged on its back, and is attached by a bolt to the lever which actuates the releasing mechanism of the tractor parachute. The suspension system is attached by a cable to the upper part of the seat through an intervening brake, the cable itself passing round from the tail without touching the rudders. When the pilot actuates this lever the bolt detaches the front of the seat, and this rocks about the flange of the back, under the pull of the parachute, and thus quits the aeroplane in good condition.

Fig. 8.

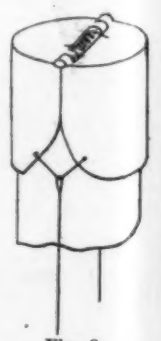


Fig. 9.

DETAILED DESCRIPTION OF THE COUADE-SLOAN PARACHUTE FOR A MONOPLANE OF FIFTY KILOGRAMMES.

Parachute.—The parachute is of Japanese pongee silk weighing 20 grammes per square meter. It is composed of 54 sections joined together by 54 double seams. The 54 suspension cords are of hemp, 2.5 millimeters in diameter and each capable of resisting 100 kilogrammes. They pass through the seams and are fastened to the periphery of a piece of sheet iron occupying the center of the hole. At their lower extremities, they join to a steel suspension

*Condensed from *Bulletin des Ingenieurs Civils de France.*

piece from which run two metallic cables, each of 2,400 kilogrammes tensile strength, which wind on the axle of the brake. The top center piece is united to the suspension piece by a cable *AB* (Fig. 4) of convenient length, designed to facilitate the unfolding.

The brake is very important and must be light and very strong, since it should absorb 30,000 kilogrammes in 0.7 seconds. We have anticipated employing three kinds of brakes from which, after trial, we shall choose the best.

1. *Brake absorbing the work by friction.*—All the types of brakes or clutches employed in automobiles can be used. For example, the brake may be composed of a

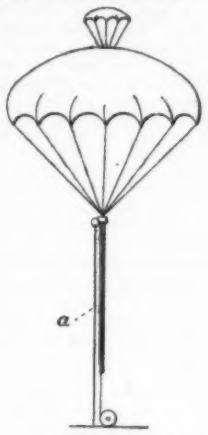


Fig. 10.

steel axle flanked by two steel drums. These drums rub against several rows of friction blocks united by metallic cables tightened by springs (Fig. 5). The brake is double and fixed to the aeroplane as shown in Fig. 6.

The work is transformed into heat, 30,000 kilogrammes corresponding to 700 calories. It suffices, therefore, to raise to a temperature of 350 deg. Cent., 2 kilogrammes of friction parts.

2. *Brake absorbing the work by the action of a tool paring material from a piece ad hoc.*—The work of tools is an element well known and of great regularity. A brake based on this principle will require repair after each operation, but this matters little. According to the studies of Schlesinger, it suffices, in order to absorb 30,000 kilogrammes, to produce 20 grammes of iron filings. The heating will naturally be considerable. This brake can therefore be very light.

3. *Hydraulic Brake.*—This brake is arranged like a cannon brake. In order suitably to amplify its displacement, we have devised the following contrivance Fig. 7. The axle consists of a tube turning in two bearings, and serves at the same time as a brake cylinder. Two pistons threaded oppositely traverse the opposite halves of the cylinder as shown, and slide without rotation along a fixed polygona bar. This bar, as shown in cross-section, has grooves so formed as to cause a progressive flow of the liquid as in a cannon brake. This brake has all the regularity desirable; its only inconvenience is its weight.

TRACTOR.

The tractor, Fig. 8, is a parachute 0.6 meters in radius, made in 8 pieces, and provided with 8 ribs which tend to spring open. The suspension cords, 1 meter in length, are attached to the center piece of the large parachute. This tractor caps the top of the principal parachute within the tube, as shown in Fig. 1.

The cap or external tractor.—To the top of the preceding tractor is attached what we call the cap, Fig. 9, consisting of two very light semi-cylindrical snap lids hinged together elastically and clasping the end of the tube. Tiny cords hold the cap closed. They can be broken simultaneously by a violent jerk of two cables attached to a lever operated by the hand of the pilot.

Release of the system. Unfolding of the parachute.—When the attachments are broken, the cap opens and draws the tractor out of the tube, which requires very little effort. This in turn opens by the elasticity of its ribs and the rush of air, and with considerable force draws the large parachute out of the tube.

When the parachute is first unfurled, its suspension cords measure 15 meters, Fig. 4. They are held together by a band, *B*, at 3 or 4 meters from their point of attachment, Fig. 10. This band can be cut by a ring forming a guillotine held to the body of the apparatus by a little cord 12 meters long. It is actually cut when the cable has uncoiled from the brake one meter, whereupon the opening of the parachute is completed.

This arrangement supports the aeroplane by the tail, and lets it down to the ground motor first. During the descent, which may last several minutes, if the fall be great, the pilot will have time to climb, by means easy to negotiate, all the way up to the suspension system and hang there. He will thus reach the earth after the aeroplane, and without velocity so to speak.

It were preferable, perhaps, to let down the aeroplane in a horizontal position, in order to profit by the shock absorption of its landing gear. The best means to achieve this will be to fix the brake, not to the aeroplane, but to the parachute suspension, and to attach the cable leading from the brake to the upper strut of the aeroplane, Figs. 11 and 12. During normal flight, a part of this cable would be inside the aeroplane.

DEMONSTRATIVE EXPERIMENTS AND OPERATIVE TESTS.

1. Demonstrative experiments with a parachute have no real value unless made with full scale apparatus of full weight falling, and operating under the severest conditions, that is to say when the fall attains a considerable velocity, say 40 to 50 meters a second. To this end the aeroplane can be attached to a free balloon by means of

Fig. 11.

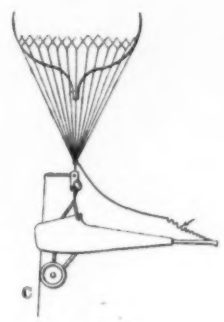


Fig. 12.

a mechanism capable of being opened by the pull of a cable *C* (Figs. 11 and 12). This cable may be so arranged as to uncoil easily from the ground to which its end is fastened.

2. Experiments on reduced models are less conclusive; still they are interesting and easy to perform. They will presently be made from the second platform of the Eiffel Tower, on a model of one fifth scale, weighing 20 kilogrammes, giving the same speed of fall (6.5 meters) as the real model. The brake will be adjusted to 100 kilogrammes and give 50 meter seconds as the acceleration, with a fall of 45 meters; the speed of descent will be 30 meter seconds, and there will still remain 70 meters for the working of the apparatus.

Forest Fires

DURING 1913 the forces on the national forests fought 4,520 fires, or nearly twice as many as started in 1912, the best year the forests have ever had.

Notwithstanding the great increase in the number of fires, Forester Graves considers that the showing made by the forest service was quite as favorable as that in the preceding year, because the damage done and the costs of fire fighting were no greater proportionately than in 1912. In both years practically 50 per cent of all fires were detected and extinguished before they burned over a quarter of an acre, and 25 per cent of both years' fires were put out before they covered 10 acres. Of last year's fires, 3,278, or considerably more than the whole number of fires in 1912, were confined to areas of less than 10 acres, and in 1,080 additional fires less than $100 damage was done by each. In only 25 fires did the damage amount to $1,000.

The aggregate loss in timber is estimated at nearly 59,000,000 board feet, valued at about $82,000, and the damage to young growth and forage is estimated at about $110,000, making a total of about $192,000. About 18 per cent of this loss, however, was incurred on private lands within the forests where 16 per cent of the fires had their origin.

One encouraging feature is that the total number of fires set by railroad locomotives was scarcely more than in the preceding year and represented only 12 per cent of all fires, as against nearly 19 per cent in 1912; also the proportion set by sawmills and other engines in the woods was considerably less than in 1912. This indicates very plainly, Mr. Graves says, that the public is awakening to the need of spark arresters and care with engines in the woods.

Looking for the reason of the increase in number of fires, the forester finds three main causes:

First of all, the unprecedented electric storms which swept the whole State of California at the end of a long dry season, and set, almost simultaneously, about 700 fires. The 804 fires set by lightning in California formed nearly 50 per cent of the 1,628 fires on the national forests of the State from all causes, and were more than half of the 1,571 lightning-set fires in all the 21 States reporting.

In the second place, there were 757 fires which started outside the forests, of which 644 were stopped by the government's fire fighters before they reached the forest boundaries, as against 424 which started on outside areas in 1912. However, the proportion of such fires to all those which the service battled with was about the same for 1912 and 1913.

The other increased cause of fires was incendiarism, but this increase was confined to three States, Arkansas, California and Oregon, all others showing a marked decrease. Of the 452 incendiary fires, 128 were in Arkansas, 133 in California, and 142 in Oregon, where two brothers were known to have set 72 on one forest alone. These two and other incendiaries were, of course, severely dealt with by the law. On the Arkansas forest, too, it has been assumed that the 351 fires classed under the general heading of "origin unknown" were mainly incendiary. In California, the incendiary fires are largely attributable to what is known as the "light-burning theory," which advances the argument that forests should be burned over frequently to prevent the accumulation of débris. The forest service considers this a pernicious theory because it scars the standing timber and thus reduces its value; it robs the forest soil of its ability to retain moisture, and effectually prevents the reproduction of the forest, since such fires destroy all tree seedlings before they have a chance to get a good start.

In 1912, lightning caused more fires than any other agency, followed closely by railroads, campers and incendiaries, in the order given. In 1913, however, the fires caused by lightning outnumbered the next nearest cause by more than three to one, but the order—railroads, campers and incendiaries—remained the same as in 1912. A considerable decrease in the proportion set by railroads and campers indicates, according to forest officers, a growing carefulness on the part of the general public.

Last year, as in 1912, California led all others in number of fires, this lead being natural because California has such a long dry season. It was followed by Arkansas, Arizona and Oregon, in the order named. Kansas, which had only one fire in 1912, escaped without any in 1913. North Dakota repeated its record of 1912 and had no fires on its one small forest. Not a single severe fire occurred during the year in District 4, which includes Utah, Nevada and southern Idaho, and in which a large proportion of the forests reported no fires at all.

There was proportionately greater loss on private lands within the forest boundaries than on the public lands. It is pointed out by the forest officers that these lands cover approximately 11 per cent of the total area included within the forest boundaries, yet the area burned over on these private lands was more than 25 per cent of all. The forest service expended more than $30,000 in protecting the private lands within the forests and lands adjacent to, and outside of the forests. In addition to this cost, services and supplies to the value of more than $17,000 were contributed by co-operators for fire-fighting on these areas.

In the middle of the fire season, that is in July, the service had high hopes of small fire damage during 1913, and this hope kept up until the middle of September, when the fire season on the national forests ordinarily is about at an end. At that time there was less damage than had ever been recorded, and only 2,260 fires as against 2,470 in 1912, with about 60,000 acres burned as compared with 230,000 in 1912 and 780,000 in 1911. At the end of the month, however, the electric storms in California and one or two outbreaks of incendiarism changed the whole situation.

But even in the face of these difficulties, the fire-fighting force, with its plans and experience from preceding years, was able to cope with the situation. In California, in particular, it was as if a military leader, represented by the district forester at San Francisco, was holding, with a comparatively small number of men, or a mere skirmish force, a line of defense extending 750 miles in a north and south direction. This force received, as if from an attack by the heavy artillery of an opposing army, the electric storms, generally unaccompanied by rain, which played havoc all along the Sierras and the Coast Range. That the California force was able to cope with the situation was, according to Mr. Graves, an evidence of the efficiency of the organization.

Crawfish are so numerous in the black prairie soil of our Central States that they destroy great quantities of forage and interfere seriously with the development of cotton and corn. Experiments in exterminating these pests have been undertaken by the Biological Survey on a tract of 75 acres of pasture land near Muldon, Miss., on which an average of 10,000 crawfish holes were found to the acre. Under the old method of catching the animals by hand at night the cost varied from $6 to $10 per acre, but the Survey has devised a method of treatment with carbon bisulphid which reduces the cost to between $1.75 and $2.50 per acre.

NEW BOOKS, ETC.

MODERN PROBLEMS OF BIOLOGY. Lectures Delivered at the University of Jena, December, 1912. By Charles Sedgwick Minot, LL.D., D.Sc. Philadelphia: P. Blakiston's Son & Co., 1913. 8vo.; 124 pp.; illustrated. Price, $1.25 net.

These six lectures are upon the subjects of the new cell doctrine, cytomorphosis, the doctrine of immortality, the development of death, the determination of sex, and the conception of life. These subjects are dealt with from a purely mechanistic point of view, and hence the titles may mislead many who are seeking for evidence of individual immortality or for any linking of the hands of science and religion in the conception of individual life. Each lecture is a thoughtful and learned review of the progress and present status of certain biological tenets, and each leads us up to the closed door before which we have so far knocked in vain.

WIRELESS TELEGRAPHY. By C. L. Fortesque, M.A., Professor of Physics, Royal Naval College, Greenwich. New York: G. P. Putnam's Sons, 1913. 16mo.; 143 pp.; illustrated. Price, 40 cents net.

This is one of the well-known Cambridge Manuals, and aims to be as simple an exposition as possible of what is admittedly a complicated subject. It gives the facts concerning the electrical phenomena involved, applies these principles to wireless apparatus, and makes a general survey of the uses to which wireless is put. A short bibliography is appended.

PORTFOLIO OF LETTERING. By Dwight L. Stoddard. Published by the Author, 354 W. Raymond Street, Indianapolis, Ind. Price, 30 cents.

These fifteen unbound sheets present for home study alphabets and designs. The penman has managed to inject into his work even more than the usual conventional ugliness, and the few lines of text merely repeat primer principles in an unappealing way.

WORKING DRAWINGS OF MACHINERY. By Walter H. James and Malcolm C. Mackenzie. New York: John Wiley & Sons, 1913. 8vo.; 143 pp.; illustrated. Price, $2 net.

The authors deal with the problem of applying mechanical drawing to the description and design of machinery, and familiarity with drawing instruments and with the principles of projections is assumed on the part of the student. The aim is, first, to impart a true conception of the character and purpose of the working drawing; second, to establish relations between pictorial drawings and orthographic projections; and, third, to present modern practice and system in a helpful way. The treatise has met the needs of the second and third year students at the Massachusetts Institute of Technology, and technical students and practical draughtsmen elsewhere will find it a helpful exposition of relationships that at present suffer from lack of a robust literature.

NATURAL HISTORY BUILDING OF THE UNITED STATES NATIONAL MUSEUM. By Richard Rathbun. Washington: Government Printing Office, 1913. 8vo.; 131 pp.; with plans and illustrations.

This bulletin consists of a descriptive account of the recently erected building in the Smithsonian Park in Washington. It houses the natural history collections of the National Museum, and embodies so many new and important features in construction and arrangement that the present paper, describing these features in full, will satisfy a wide demand for correct and detailed information. In appearance, the building is substantial and dignified. Within, the aim has been to secure the greatest possible amount of space. The building presents the appearance of a huge shell, containing few permanent division walls, and thus being admirably adapted to exhibition purposes. It has a total floor area of 465,893 square feet.

WOODWORKING SAFEGUARDS. For the Prevention of Accidents in Lumbering and Woodworking Industries. By David Van Schaack. Hartford, Conn.: Aetna Life Insurance Company. 8vo.; 217 pp.; illustrated. Price, $1.

The logging camp and the saw mill are fecund of accidents. "Woodworking Safeguards" gives a great deal of very specific and practical information as to commonsense methods of averting accidents from saws and running machinery. Pattern shop and box factory practice is included, and the suggestions of the pamphlet may be extended to machines and conditions other than those of the woodworking industries.

L'ÉLECTRICIEN AMATEUR. A L'Entrainement. Services Électriques Variés, Inédits et Pratiques Pouvant Être Réalisés avec la Plus Grande Facilité sur Toute Installation Domestique Alimentée par une Batterie de Piles. Par Georges Mis. Avec une préface de M. J.—A. Montpellier. Paris: H. Dunod et E. Pinat, 1914. Prix, 2 fr. 50.

This little book initiates the amateur into the mysteries of electric lights, bells, and batteries and the methods of their installation, with much other information relating to such electrical principles and apparatus as the amateur wants to know.

THE MECHANISTIC PRINCIPLE AND THE NON-MECHANICAL. An Inquiry Into Fundamentals with Extracts from Representatives of Either Side. By Paul Carus. Chicago: The Open Court Publishing Company, 1913. 8vo.; 125 pp. Price, $1.

The author, while presenting the arguments of both schools, himself inclines toward the mechanistic theory of life, since, as he says, "the whole process of causation is always mechanical and takes place according to mechanistic principle, because every transformation means change of place (motion) and a rearrangement of parts." However, he maintains what he calls "the divinity" of the mechanical law, conceding the presence of purpose in the world, and in religion recognizing a phenomenon that develops naturally and necessarily, and thus must be reckoned with among other phenomena. Extracts from Mark Twain's "What is Man?" from La Mettrie's "Man as a Machine," and from an article by Prof. W. B. Smith on "Push? or Pull?" make up the remainder of the volume.

MEMORY. Lectures on the Specific Energies of the Nervous System. By Prof. Ewald Hering, University of Leipzig. Chicago: The Open Court Publishing Company, 1913. 12mo.; 72 pp. Price, $1.

Prof. Hering has an interesting theory that specific color-sensations are due to the relation of assimilation to dissimilation of protoplasmic visual substances in the retina or brain. This theory is extended into the essays on "The Specific Energies of the Nervous System," and "The Theory of Nerve-Activity." The three lectures make a most readable little volume.

LIFE AS IT IS. By William Timothy Call. Brooklyn, N. Y.: W. T. Call, 1913. 12mo.; 89 pp. Price, 50 cents.

Mr. Call's latest booklet is a classified collection of humor. The reader will meet many old friends among the squibs and anecdotes, but most of those honored with a place in the collection are worthy of being met twice. The initial section of the slim volume is entitled "Mulraney," and is the story of a murderer as told in the newspaper accounts. Thus, "Life As It Is" is presented as a see-saw between horror and laughter.

THE EVACUATION OF ENGLAND. The Twist in the Gulf Stream. By L. P. Gratacap. New York: Brentano's, 1908. 12mo.; 321 pp.

The author must have something of a grudge against England and the English, for he makes his English hero lose twice in love, and drives the whole population of the British Isles to abandon their countries before the attack of white-fanged blizzards. The strength of the book lies in its descriptive passages, which in places rise to heights of realism. The author handles catastrophe better than character and is ingenious in weaving physiographic theories into his fictional fabric.

THE OBSERVER'S HANDBOOK. Approved for the Use of Meteorological Observers by the Meteorological Office, the Royal Meteorological Society, the Scottish Meteorological Society, the British Rainfall Organization. Annual edition, 1913. London: H.M. Stationery Office, 1913. 8vo.; xxiv, 157 pp.; illustrated. Price, 3 shillings.

From year to year this annual publication of the British Meteorological Office becomes more useful and interesting to everybody who is in any way concerned with the study of the weather—not merely to the professional meteorologist. It is, in fact, addressed primarily to the non-professional weather observers who constitute so numerous a class among educated Britons. The edition of 1913 (published at the end of that year) offers a special attraction to all students of the physical sciences in the shape of a 15-page explanation of the new meteorological units, on the C.G.S. system, to the adoption of which the Meteorological Office is now definitely committed, and which are destined to bring the science of the atmosphere for the first time into intimate community with other physical sciences and their applications. The *rationale* of "millibars," degrees of temperature on the absolute scale, and other (to the meteorologist) novel conceptions is set forth in a masterly manner. An important distinction is brought out between the "millibar," which is an absolute unit of pressure (= 1,000 dynes per square centimeter) and the "baromil," which, in the meteorological millennium now near at hand, is to be used for the empirical graduation of barometers.

Another new feature of this edition is a series of beautiful cloud pictures, from photographs by G. A. Clarke, of Aberdeen Observatory.

The older features of the Handbook include clear descriptions and explanations of meteorological instruments and their *modus operandi* (naturally of the types used in Great Britain, differing in many cases from our own); also detailed accounts of the Beaufort wind-scale and its equivalents; of weather in all its phases and the symbols for recording it; and of the principal optical phenomena of the atmosphere.

American students will find this work a valuable supplement to the publications of our own Weather Bureau and to American textbooks on meteorology.

COST ACCOUNTING. Theory and Practice. By J. Lee Nicholson, C.P.A. New York: The Ronald Press Company, 1913.

Nicholson's "Cost Accounting" cuts the subject down to its essential elements, dispensing with all matter pertaining to details of factory organization and efficiency methods that does not come strictly within the scope of cost accounting principles. Both accountants and manufacturers will find here succinct but readily understandable expositions of all phases of cost finding and the compilation of cost data. Among questions intelligently and helpfully dealt with may be listed the following: Interest in its relation to cost; methods of distributing indirect expenses; compiling cost data; the examination of a plant; devising a cost system; departmental systems; systems based on the productive labor method, on the machine method, etc. The work includes all necessary forms, whether they relate to material production orders, time reports, or sales and financial records. There are two charts showing the special order system under the productive labor method and under the process of machine method; while two others demonstrate the product system under these methods. In works such as the two in hand there is always room for honest difference of opinion upon some of the finer problems of practice, but this is inseparable from all arts and sciences, and the works are none the less to be unqualifiedly commended not only to the accountant, but also to the business man, who will find little difficulty in grasping the general features of procedure.

TECHNISCHES AUSKUNFTSBUCH FÜR DAS JAHR 1914. By Hubert Joly. Leipzig: K. F. Koehler. 7¼ by 4½ inches; xvi + 1531 + lviii pp. Price, 8 marks.

The volume before us is the twenty-first annual issue of a handbook which has deservedly found great popularity. The arrangement of the subject matter is alphabetical, in fact the work is of the nature of an encyclopedia of engineering data covering a very wide field. To give an idea of the diversity of the subjects treated, the following keywords, picked out at random, may be quoted: Torches for Burning off Oil Paint; Working Hours in Factories; Lightning Conductor Wires and Cables; Alcohol Distilleries; Moisture Gage for Steam; Diesel Motors; Lathes; Windows; Fire Engines; Manufacture of Illuminating Gas; Employers' Accident Liability; Wood; Wood Preservation; Chains and Cables; Linoleum; Solders; Air; Flying Machines and Airships; Elevators; Suction Gas Producers; Check Accounts; Explosives; I-Beams; Water Purification; Toothed Wheels; Custom Duties in Different Countries; Mathematical Tables, etc. This book is a rich mine of information. In the case of materials of construction, not only the physical properties, but also typical market prices (German) are given. To those who know the book, it requires no recommendation. Those who do not know it will find it to their advantage to become acquainted with it.

THE PROGRESS OF SCIENTIFIC CHEMISTRY IN OUR OWN TIMES. With Biographical Notices. By Sir William A. Tilden, F.R.S. New York: Longmans, Green & Co., 1913. 8vo.; 366 pp. Price, $2.25 net.

This work was first issued in 1899, but has lately been brought up to date. It addresses itself to the student, and provides "a clear statement of the successive steps which have led to the system of theory generally accepted by chemists at the present day." No finality can be claimed for so elusive a subject, but a study of the difficulties confronting early experimenters and of how these difficulties were met, must constitute an essential part of the equipment of the modern investigator. The work contains chapters on the distribution of the chemical elements in nature; the rectification and standardization of atomic weights; valency, and the linking of atoms; and electrical and chemical affinity. The discoveries relating to radio-activity are also chronicled. Each branch of the discussion is accompanied by biographical notes, thus linking prominent names to the general progress of the science, and giving credit where credit is due.

FREIGHT RATES. Lesson Assignments 6, 7, and 8. By C. C. McCain and William A. Shelton, A.M. BASES FOR FREIGHT CHARGES. By C. L. Linge. THE INDUSTRIAL TRAFFIC DEPARTMENT. By W. M. Agnew. STATISTICS OF FREIGHT TRAFFIC. By Julius H. Parmelee, Ph.D. Chicago: LaSalle Extension University. (Non-Resident Instruction.)

These are late issues in the text-book series on Interstate Commerce and Railway Traffic. The three texts on Freight Rates deal, No. 6, with all rates east-bound; No. 7, with Canadian percentage territory rates, rail and water rates, and the development of the percentage system; No. 8 continues with port, inter-territorial and local. The treatise on "Bases for Freight Charges" presents the subject of freight tariffs and their determining factors, with a consideration of weights, special charges, and the legality of rates. "The Industrial Traffic Department" recounts the duties of the traffic manager and the routine of the department. "Statistics of Freight Traffic" includes railway mileage, equipment, capitalization, revenues and expenses. These recent issues, by experts in their particular lines, continue the well-ordered dispensing of information which we took occasion to commend in the earlier texts of the course.

RADFORD'S ESTIMATING AND CONTRACTING. Chicago: The Radford Architectural Company, 1913. 12mo.; 887 pp.; illustrated. Price, $2.

Accurate estimating is vital to the success of the contractor and builder, and is by no means an easy accomplishment to master. Sound, systematic methods of procedure are essential, and it is these methods which the work in hand discloses. The cost of material varies according to location and other conditions, but the factors of quantity and time are fairly constant. It is these factors that the student is taught to handle with accuracy, and every branch of the building problem, from frame and masonry constructions to painting, plumbing and wiring, is progressively dealt with. There are also sections on sidewalks, bridges and culverts, and sewers and conduits. Such information as can be tabulated is presented in that exact, time-saving form, and engravings, diagrams, and a detailed index add to the value of an intensely practical volume.

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